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REPLACEABLE AND IRREPLACEABLE RESOURCES AND LAND USE

A. B. COSTIN

Ecology and conservation have been with mankind in one form or another since the beginning of history, but it is only during the last century and particularly the last 50 years that they have emerged as definite sciences. Applied together in the modern sense, ecology and conservation seek to achieve the fullest use, improvement and equitable distribution, in terms of public benefit, of the natural resources of the world. This approach sees man essentially as part of his environment, not separate from it.

An adequate appreciation of conservation is facilitated by examining the historical evidence. For instance, it is now difficult to realise that in the millennia B.C., Mesopotamia, Egypt, Palestine, Syria and Persia were fertile lands with forested hills and mountains, supporting thriving civilisations based on elaborate conservation schemes. There were extensive irrigation works complete with dams and complex reticulation systems. Some of these, such as the huge Nahrwan canal which ran for 200 miles parallel to the River Tigris, still rival the largest modern works in the boldness of their conception (Hartley 1957). Flood protection measures by means of dams and embankments were also well developed. Some of these works flourished for centuries and both on economic grounds and in comparison with modern schemes were highly successful. Today virtually nothing remains. It is accepted by many that increasing deforestation and overgrazing of the hills and mountains, with increasingly rapid run off and siltation of rivers and irrigation waters, were important factors in this disintegration (Bennett 1949). These examples are given simply to direct attention to the relative importance of replaceable and irreplaceable natural resources. The conservation practices of these ancient Mediterranean civilisations were centred mainly on the replaceable natural resource of water; relatively little emphasis was given to the irreplaceable resources, the soil and the type of terrain which made irrigation possible. By way of contrast, the pre-Inca agriculture, which gave high priority to soil conservation, has persisted in places to the present day.

The distinction between replaceable and irreplaceable resources, and the appreciation of their relative importance in relation to the variables which constitute environment, are basic to the ecological approach to resources conservation. A simple arrangement of these resources is as follows:

Inexhaustible Resources: The total amount of matter as atmosphere; water; land.

Replaceable and Maintainable Resources: water in place; vegetation; animal life (including human populations).

Irreplaceable Resources: minerals; soil; land and landscape in the natural condition.

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Inexhaustible Resources

The total amount of matter is virtually inexhaustible, but the form in which it occurs is subject to change, particularly in respect to its suitability for living things. Any permanently deleterious change in the composition of this matter, as by radio-active contamination, is therefore a matter for concern. These resources are not, however, the subject of this paper.

Replaceable and Maintainable Resources

The concept of replaceable and maintainable resources, stated in its simplest terms, means that the production of these resources is primarily a function of the environment and if environmental conditions are suitable the resource in question will continue to be produced. Conversely, impairment of the environment will result in reduced production of the resource.

One of the nicest examples of the regenerative power of habitat with respect to a particular organism is that of the fur seal on Macquarie Island, given by Carrick (1957). Between the years 1810 and 1813, more than 180,000 seal skins had been taken and by 1820 the fur seal on Macquarie Island was reported extinct. The Australian Antarctic Expedition party on Macquarie in 1911-1913 saw no seals. It was not until the expedition of 1948 that they were again reported. By 1955 the population exceeded 200 and it continues to increase. In other words, very heavy harvesting of populations of animals or plants is possible without permanent damage provided the environment remains intact.

The same feeling has been growing with respect to marine fisheries—that it may be practically impossible to fish out an area permanently. Provided the habitat remains suitable the fish will continue to be produced. Conversely, with respect to trout fisheries, measures aimed at the fish population directly, namely restocking the streams with fingerling trout, limitations on the fishing season, minimum size and maximum permissible catch, appear to be relatively ineffective in Australia since most streams are stocked to capacity already (Nicholls 1958). In these instances improvement of the habitat offers better possibilities for improving production (Costin 1957-58).

Simple and obvious though these facts are, they are continually overlooked in much of the applied ecology and conservation of today. Too much effort is often concentrated on the resource itself (e.g. vegetation, animal life) to the neglect of the environmental conditions which produce it. The various approaches to weed and pest control provide further instructive examples. These approaches fall into one of three main categories—measures aimed directly at the animal or plant; measures aimed at the animal or plant through some predator or parasite; and measures designed to operate through changes in the environment itself.

With direct measures of the first category, it should be remembered that the plants or animals in question will continue to be produced as long as habitat conditions are suitable. Therefore this type of control measure usually has only a temporary effect and it follows that poisoning, trapping, etc., must be cheap enough with respect to the crop or pest in question to be applied continually. Unless this is possible—and it often is, as with 1080 poisoning of rabbits—direct control measures are not likely to be worthwhile.

The second approach, aimed at influencing particular plants or animals through predators or parasites, seems to have been over-glamorised by biologists who too frequently refer to the spectacular control of prickly pear by *Cactoblastis cactorum*. To achieve such a high measure of control by such means is unusual. In this type of situation a self-adjusting balance is usually set up between the host and parasite, resulting in only a partial reduction in the host population. Such a balanced relationship has been demonstrated over recent years by the rabbit and the myxoma virus in Australia. The initial highly fatal parasitism is changing to a stable situation in which a considerable rabbit population will probably be maintained. Therefore when only a partial reduction in the population is considered to provide adequate control, the host-parasite method may be satisfactory, but where more complete control is needed, other methods should also be used.

The growing appreciation that vegetation and animal communities are essentially dependent and renewable variables is focusing greater attention on the possibilities of manipulating populations through changes in their habitat. This method is not, however, particularly attractive to the practical man, since it often operates in a manner which is apparently disassociated from the organism concerned. It also demands a thorough ecological study of the organism in relation to its environment as a necessary background. The changing attitude to weeds such as Skeleton Weed and Nassella Tussock illustrates the growth of this newer approach in weed control.

A substantial reward was once offered by the New South Wales Department of Agriculture for successful control of Skeleton Weed in wheat lands. A notable Temora farmer, the late William Giles, applied for the reward on the basis that the weed could not only be controlled but also put to good use by incorporating a year or two of grazing by sheep into the usual wheat rotation. At this time direct control by poison salts dominated thinking, and Giles' claim was not seriously considered. Today his measures form the basis of control, and in places of a profitable fat lamb industry. Similarly, a depleted overgrazed pasture is now recognized as a predisposing factor for Nassella invasion, while the maintenance of a dense, vigorously growing pasture during the growing seasons is considered the most suitable control measure.

It has recently been suggested that, at least in some of the high rainfall areas, high rabbit populations may be a consequence of land deterioration rather than a cause of it. If this is so, then rabbit control in some of these areas may be as simple as establishing and maintaining a dense growth of herbaceous vegetation. In the snow grass areas of the Australian Alps, and in parts of New Zealand this seems to be the case (Costin 1958).

These examples serve to demonstrate the limitations of the various approaches, and emphasise the essentially dependent and renewable character of plant and animal communities with respect to their environment.

Irreplaceable Resources

Of the irreplaceable resources listed, the *minerals* are in a special category, inasmuch as once used they cannot be replaced. So far, technological progress has been able to keep pace with exhaustion of high grade deposits, by providing cheaper methods of treating lower grade materials. Some see the ocean, which contains many of the minerals needed by man, as the ultimate source of many future needs. In all cases, however, and particularly with respect to minerals approaching exhaustion such as tin, petroleum and coal, the general conservation principle applies that utilization should as far as possible be for the most valuable purposes rather than for needs which can be met by the use of alternative materials which are more abundantly supplied.

Some properties of *soil,* such as organic content and structure, are replaceable, but the actual amount of soil in a given area can, for practical purposes, be regarded as a non-renewable resource. Turning again to the brief historical account of conservation given previously, it can be seen that productivity has been maintained where conservation measures were directed at the soil itself, as in the terraced agriculture of Peru. The far more complex conservation schemes of the Eastern Mediterranean region, that concentrated on the storage and reticulation of the renewable resource water but disregarded the irreplaceable soil and landscape resources, have almost entirely disappeared.

The conservationist is sometimes accused of being unjustifiably dramatic about the need for soil conservation despite the historic evidence and despite the fact that the so-called progressive countries like Canada, South Africa, Australia and even the United States with its tremendous soil conservation organization, are still rapidly losing ground.

It is easy to be misled by the phenomenal progress which is being made by the agricultural scientist in his development of fertilizers, improved farming techniques, plant introductions, higher yielding varieties, animal dips, drenches and vaccines, washable wool brands, weedicides and so on. It needs only a little thought to appreciate that most of these improvements relate to the dependent and re-

newable components. The analysis by Cornish (1949) of the wheat yield trends in South Australia between 1896 and 1941 is a major contribution in this regard. After eliminating the renewable variables tending to increase yields, such as phosphatic fertilizers, cultural practices and higher yielding varieties, there remains a distinct downward trend in wheat yield attributable to progressive loss of soil nitrogen and soil structure. These changes in themselves are partly reversible, but the concomitant erosion damage which Cornish described is not. Forster demonstrated similar changes in the wheat soils of Victoria and Hallsworth and Gibbons in the black wheat soils of North West New South Wales (Forster 1950).

The point which needs to be made is that this is still the situation for most types of land and land use in Australia. The increase in productivity in primary industries has been achieved almost entirely by improved techniques affecting the renewable components of the eco-system, to the extent that changes in the non-renewable components have been obscured. In the Southern Tablelands and Monaro Region of N.S.W., for example, more productive sheep have been developed, sheep diseases have been largely controlled and native pastures over wide areas have been modified by artificial fertilizers and the introduction of subterranean clover. In normal years, production is high and the soils are fairly well protected. Recurrent droughts are, however, a regular feature of this environment, as of most parts of Australia, and corresponding livestock and economic losses have been very high (Foley 1957). On the other hand, the grazing industry has so far been able to sustain these setbacks, which on purely economic grounds have therefore been tolerable. That such population crashes are symptomatic of environmental maladjustment requires no argument. What is not so often realized is that these high populations at times when the environment is most vulnerable often initiate serious soil erosion and, furthermore, that this erosion may continue long after the high population pressure is removed.

The present trend over extensive pastoral areas of Australia is for fertility to be concentrated in a minority of favourable situations, such as parts of the lower slopes and flats, whilst it is being lost on a far more extensive scale from the hill country and the steeper slopes. On these more vulnerable areas an improved annual pasture is not particularly effective in preventing surface run-off and soil loss from heavy rains following dry periods. Other serious and often irreversible consequences of these impaired hydrological conditions are the development of salted land and the formation of creeks and gullies where none existed before. These changes represent both a loss of soil as such, and a permanent lowering of the water table. A regression analysis of the type carried out by Cornish for the South Australian wheat lands would probably produce similar results for the grazing industry.

Three further points must suffice for this part of the discussion. The first is the changing attitude which is developing in some quarters towards criteria for evaluating grazing lands. The production per unit area, either of desirable pasture or of livestock has long been given major emphasis, but there is now a growing tendency to give greater weight to the minimum cover conditions which should be maintained through severe periods. This newer approach is being applied to some of the American range lands (Hedrick 1958) and in the high mountain catchments of Australia (Australian Academy of Science 1957).

The second important point about a non-renewable resource like soil is that downgrade changes can be largely irreversible in that they persist and even intensify after the disturbing agent is removed. The initiation of creeks and gullies in valleys containing deep soil, is a good example. Another instance is the deterioration of exposed parts of the Kosciusko plateau, where soil erosion continues although there has been virtually no grazing since 1944.

The third point to which brief reference should be made is the over-emphasis which research work seems to give to the renewable components of the eco-system. Basic problems of long-term soil stability and fertility are being virtually ignored. Possibly such

problems are less amenable to exact experimental procedures, but this should be no excuse for continuing to avoid them in the future.

The final irreplaceable resource listed—*land and landscape in its natural condition*—covers a very wide field, but it is a convenient reference point for the final part of this section. For practical purposes, changes in the landscape are irreversible. Certain types of landscape are abundantly supplied but others, such as harbours and reservoir sites, are scarce, particularly in the geographic situations in which they can be used. Furthermore, they can easily be alienated by many kinds of land use i.e., the development of a particular area for a particular purpose often precludes its development for something else. This again emphasizes the need for reserving land as far as possible for the highest kind of use to which it can be put. The need for this approach is increased by the fact that the use of land for many purposes often tends to be an irreversible process, due to the social, economic and political pressures which subsequently develop to have these uses continued.

By far the most important and restricted type of landscape in Australia, as in most of the drier countries, are suitable reservoir sites in the localities which both receive considerable quantities of water and which are not too far removed from areas where the stored water can be used. If these sites are lost by other types of use (e.g. the building of large towns or cities), or by siltation, there may be no other alternative sites. The situation is further complicated by the fact that large reservoir schemes are the basis of new enterprises such as irrigation in areas which could not otherwise support them; if the function of the reservoir is increasingly impaired, then the dependent enterprises suffer and in time some of them must go out of existence. This has been noted already in the case of the Eastern Mediterranean region where whole civilizations have disappeared. Some of the heavily salted irrigation areas of northern Victoria fall into a similar category. The capacity of Melton Reservoir, which supplies water for the Werribee Irrigation Area near Melbourne, has already been reduced by siltation to a major degree. It is a disturbing thought that the huge Lake Mead impounded by Hoover Dam on the Colorado River is given a life of not more than about 200 years.

As far as the engineer is concerned, a construction project can usually be justified if the expected economic returns compare favourably with the expected costs. Where suitable reservoir sites are in abundant supply the conservationist would be in substantial agreement with the engineer's approach, but where they are not, the economic criterion would not be given highest priority.

The problem of road sites in difficult country provides another example. The loss of the existing site by erosion following bad road location or design usually means that the development of alternative sites becomes increasingly expensive and in very difficult situations there may be no alternatives at all.

Multiple Purpose Use

The problem of multiple purpose use, which has already been touched upon several times, requires further comment. To what extent can several demands on a single resource be satisfied without impairing it? In many instances highly satisfactory compromises can be made, but in other cases the concept of multiple use is misunderstood and erroneously applied to mean that the same area should be called upon to serve as many purposes as possible. The more or less indiscriminate use of many of the mountain and foot-hill catchments in Australia for grazing is a case in point (Costin 1957). Fortunately, this idea of multiple use of an area appears to be changing to an attitude which accepts the principle of multiple demand on the area as a whole but which satisfies it by detailed subdivision of that land into units suitable for various specific purposes. The concept of multiple use of an area now becomes one of specialized use of the various parts of the area. The application of this principle is very well seen in Southern Sweden where the flats and lower slopes are intensively managed as agricultural and grazing land and the upper slopes intensively managed as forests. There

are not the unproductive half measures of inferior forest-grazing land that are so widespread in Australia.

Land Use Capability

Most of the principles discussed above are now being accepted by conservationists concerned with resources development, and are being embodied in the approach usually referred to as land use capability planning. This approach is based on broad ecological principles. It appreciates that various kinds of land and other resources are naturally more suitable for certain kinds of use than for others, and it aims to ascertain what these most suitable uses are and subsequently to have them applied in each individual case. Naturally defined land units of similar productive potential are recognized by studying the environment as a whole and its individual components. These units are then classified into land use capability groups. Existing utilisation of an area may of course bear little relation to the use for which it is most suitable.

Land use capability can be assessed for areas ranging in size from vast natural regions down to individual farms and fields. The Tennessee Valley Scheme in America is probably the best example of this approach on an extensive scale. Here the aim of planning was to develop water resources and to rejuvenate the valley system as a whole, including its inhabitants. Land use schemes in Australia often present a marked contrast insofar as they are limited purpose projects and lack the overall ecological approach. To some extent the State-Commonwealth political system appears to be the stumbling block, but another cause is that our thinking, in some quarters, has not yet advanced far enough.

The land use capability approach should also form the basis of scientific farm planning and development, not only for undeveloped land but also for existing farms. A few land use authorities have now almost arrived at the stage where when asked for assistance in a particular conservation problem such as gully control, they are reluctant to give it unless the farmer also agrees to the complete planning of his property. This often means drastic changes in farm layout, management, and type of production. Inasmuch as individual farms themselves are often unsuitable units for self-contained management, the farm planning approach should also be extended to groups of farms and to complete catchment areas.

This approach represents a major turning point in the attitude towards conservation—that its primary function is planning at the drawing-board stage. The bolstering up and perpetuation of former mistakes, as with check dams and contour banks on grazed land which should never have been grazed, or grass-sodding on aqueducts and roadside batters in situations basically unsuitable for engineering works, should in future be regarded as only a relatively minor aspect of conservation activities.

This approach demands a broader understanding by ecologists and conservationists of natural systems as a whole and of the interrelationships of their components. It does not belittle the increasing importance of the specialist but it does seek to have the special knowledge applied with perspective. For instance, a given amount of time spent over conventional plot trials studying one of the individual components in a catchment area, can often be far better spent in accurate observations of the behaviour of the catchment area as a whole. Fraser Darling (1956) has put this view well by pointing out that "large fields of ecology can never be investigated experimentally and we need to learn a good deal about comparative observations as a means of overcoming experimental difficulty".

On this point it is of interest to record that the teaching of ecology at the University of Georgia has been changed to fundamentally different lines (Odum 1957). Instead of beginning with the conventional treatment of the separate components of the environment, without much reference to their interrelationships, the starting point is now a simple ecological system such as a pool, a cultivation paddock, or a clump of trees. The understanding of systems as functional units is thus regarded as the primary aim of ecology. At a still higher teaching level the Department of Natural Resources at Michigan under Cain,

and the Department of Conservation at Yale under Sears, are also developing along broad lines. In Australia, similar institutions are long overdue.

The concluding point is largely a restatement of the beginning. Conservation is the wise use of natural resources, based on sound ecological principles. The object of study is the system as a whole, rather than isolated components of it. Viewed in these terms, conservation becomes an essential component of human ecology. Unless we take this broader view, then, in a world of increasing specialisation, there is a real danger of not being able to see the wood for the trees.

The two approaches to the conservation problem, as seen by Boulding—"Man's Role in Changing the Face of the Earth", by W. L. Thomas and others, University Chicago Press, 1956.

A CONSERVATIONIST'S LAMENT

The world is finite, resources are scarce,
Things are bad and will be worse,
Coal is burned and gas exploded,
Forests cut and soils eroded.
Wells are dry and air's polluted,
Dust is blowing, trees uprooted.
Oil is going, ores depleted,
Drains receive what is excreted.
Land is sinking, seas are rising,
Man is far too enterprising.
Fire will rage with Man to fan it,
Soon we'll have a plundered planet.
People breed like fertile rabbits,
People have disgusting habits.
Moral:
The evolutionary plan
Went astray by evolving Man.

THE TECHNOLOGIST'S REPLY

Man's potential is quite terrific,
You can't go back to the Neolithic.
The cream is there for us to skim it,
Knowledge is power, and the sky's the limit.
Every mouth has hands to feed it,
Food is found when people need it.
All we need is found in granite
Once we have the men to plan it.
Yeast and algae give us meat,
Soil is almost obsolete.
Men can grow to pastures greener
Till all the earth is Pasadena.
Moral:
Man's a nuisance, Man's a crackpot,
But only Man can hit the jackpot.

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It cannot be said that there is a lack of appreciation for a good claret in Australia, nor does a good claret escape recognition, as the following list of more recent tributes in the form of show awards testifies :

1954 VINTAGE . . . . . *1st Melbourne, 1954*
1954 VINTAGE . . . . . *1st Adelaide, 1955*
1955 VINTAGE . . . . . *1st Adelaide, 1955*
1956 VINTAGE . . . . . *1st Melbourne, 1956*
1956 VINTAGE . . . . . *1st Sydney, 1958*

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PLANT VIROLOGY IN AUSTRALIA

L. L. STUBBS

The investigation of plant viruses in Australia has followed an erratic and often unplanned course, and even today, the importance of these pathogens is not fully recognized in scientific agricultural circles.

In the early days of plant virology in Australia—and for the beginning one need only go back to the mid-twenties—the ratio of virus to other plant disease investigatory work compared favourably with that of any country, and its quality was relatively high by world standards. Unfortunately, the ratio has failed to increase as it has in other countries advanced in agricultural research.

At present we find in Australian scientific journals a mere trickle of virus papers, whereas in similar overseas journals, a considerable and increasing proportion of papers is concerned with plant viruses and the diseases they induce. There is also a great dearth of fundamental work — and this in a country where basic research on human and animal viruses is rated highly by international standards.

The reasons for this situation would appear to be failure to recognize the importance of virus diseases in practically every branch of plant production, and failure to provide the specialized facilities and equipment required for their investigation. Although electron-microscopes, ultra-centrifuges and ancillary equipment are now relatively common in plant pathology or plant virus laboratories overseas, they are still considered dispensable in Australia.

The loss of several experienced virologists at a time when their experience and influence was most required, and failure to replace them, also undoubtedly had a marked effect on the recent development of plant virology in Australia.

Fortunately, there are now signs that plant virology is emerging from the doldrums, but there are still too few to cope with the problems of the present.

The Recognition of Virus Disorders

Virus diseases have been identified on practically every agricultural species grown in Australia, with the exception of cereals and pasture grasses. We will be fortunate if, unlike North America and Europe, Australia is free from viruses which infect these species.

Perhaps we will find, as we did with pasture legumes and some other species, that virus diseases of grasses occur un-recognized, or have been incorrectly attributed to other factors.

In Victoria, recognition of the viral cause of the serious subterranean clover stunt disease (Grylls and Butler 1956; O'Loughlin 1958), was delayed because of the similarity of disease symptoms to those on magnesium deficient plants, and because a statistically significant response to that element was obtained in a preliminary field trial. Similarly, the practically universal occurrence of the motley dwarf virus disease of carrot in Victoria, caused the author initially to seek a nutritional cause (Stubbs 1948).

As the symptoms induced by viruses on host plants are legion, and infinitely variable, virologists are now looking more closely at problem disorders where the cause remains obscure. Many diseases now known to be

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caused by viruses were originally attributed to fungal, bacterial, nutritional or other physiological causes, and the stage has now been reached in plant pathology where, if the cause and response is not clear-cut, a viral explanation should be sought.

With plants that are propagated vegetatively, such as most fruit species, sugar-cane, potato and sweet-potato, varieties are prone to universal infection with a virus or virus complex. Proof of the existence of viruses in these species is sometimes difficult, because of the absence of known healthy material for transmission tests. Such tests are necessary to reproduce the disease, as plant viruses are obligate parasites, and cannot be cultured outside the tissues of their hosts.

With rare exceptions virus diseases can be transmitted by grafting, and many plants not normally propagated this way can be grafted by specialized techniques. For plants anatomically unsuitable for grafting, other virus transmission methods have been devised. Viruses which are concentrated in epidermal tissues are frequently sap-transmissible. The indicator or test species—usually a seedling—is dusted with an abrasive, such as fine carborundum, before inoculation. This operation is performed by rubbing the leaves of the test species with an extract from an infected plant, normally prepared by grinding an infected leaf with phosphate buffer solution at pH 7. The transmission rate is usually increased if the inoculum is washed from the inoculated leaves with water, which removes virus inhibitors present in sap extracts of some species, or toxic substances which may injure the inoculated plant.

Viruses concentrated in the phloem or, rarely, xylem tissues, are frequently transmissible only by insects. Sometimes the discovery of an insect vector requires a long and painstaking search which involves the testing of many different species of insects for vector ability. For example, the vector of the peach mosaic virus in the United States remained undiscovered until seventeen years of insect screening, involving more than 8000 tests of 150 insect and mite species, revealed a minute mite (*Eriophyes insidiosus n.* sp.), present in the tightly appressed bud scales of retarded buds of peach, and other species, for short periods in the spring and late summer (Wilson *et al.* 1955). This, however, is an extreme example, and to the experienced plant virologist the nature of the disease, and its pattern of spread in the field, sometimes suggests the type of insect to be screened when seeking a vector.

Many cases of incompatibility of stock and scion in fruit species are now known to result from virus infections. Attention was first focused on the different reactions of stock and scion varieties to a virus infection by Rawlins and Parker (1934), in the case of the buckskin disease (Western-X virus) of sweet cherry. They described typical buckskin disease symptoms of cherry on mazzard stock, and decline symptoms on mahaleb stock. They also produced evidence that the latter resisted passage of the virus.

The most important disease of this type is, undoubtedly, the tristeza (quick decline, etc.) disease of sweet orange and mandarin varieties on sour orange rootstock. Strains of the tristeza virus have now been recorded in most of the important citrus growing regions, but not all regions have strains which cause decline of susceptible combinations. Decline strains occur in North and South America, Australia, Africa and Asia.

Where the most efficient vector, the brown citrus aphid (*Toxoptera citricidus* Kirk) occurs, it is no longer possible to grow the principal citrus species on non-tolerant rootstocks, such as the desirable Phytophthora root-rot resistant sour orange varieties.

Tristeza virus strains multiply in tolerant citrus species such as sweet orange varieties, without apparent effect on vigour, but these varieties are readily infected with the virus. Sour orange varieties are, however, resistant to infection with tristeza when inoculated with aphids, but not when inoculated by budding or grafting.

When the susceptible top of a combination tree becomes infected, sieve tube necrosis occurs in the phloem of the sour orange rootstock at the bud-union. Transportation of

food materials synthesised by the leaves is impeded, and the starved roots gradually disintegrate. The first evidence of root deterioration is foliar development of nitrogen deficiency symptoms, frequently accompanied by excessive flowering. Decline and death of the tree usually follows.

Similar diseases are caused by widely distributed latent infections of pear stunt virus in pear varieties, which prevent their propagation on quince rootstocks (Posnette 1956), and by a strain of cucumber mosaic virus on black passionfruit (*Passiflora edulis* Sims) when the latter is grafted onto *P. caerulea* L. rootstock. In the latter example the stock is more susceptible to cucumber mosaic virus than the scion variety, and apparently supports a higher concentration of virus than the scion (Taylor 1957).

Most plant viruses in Australia are spread by insects. A few, such as ratoon stunting virus of sugar cane, tobacco mosaic and potato X viruses, are highly infectious and are spread by the cutting knife, pruning or foliage contact. There would appear, however, to be a number, particularly on tree fruits, which are spread only by man. For example, the extremely high incidence of apple mosaic disease in Victoria might be explained by the widespread use of virus-infected vegetatively propagated Northern Spy rootstock, which carries some strains symptomlessly.

It is likely with other fruit and vine varieties that early introductions were infected, and we have never known healthy material. It would, therefore, seem reasonable to predict that propagation of apples, pears and grapes, from virus-tested material (it is safer to say virus-tested than virus-free as latent infections are continually being recognized) will produce some interesting results.

Increased vigour and greater cropping ability is, of course, expected. But, as a virus deranges the nucleoprotein metabolism of its host, abnormal physiological development may lead to other changes—such as differences in fruit quality. Will we find, for example, that the character of wine made from healthy grapes has changed entirely from that made from virus-infected grapes, or that 'healthy' apple or pear varieties have different cold storage requirements to those we have always grown? Similarly 'healthy' varieties may react differently to foliage diseases caused by fungi or may be more or less susceptible to injury from fungicides or insecticides.

Answers to many of these questions should be provided in the near future.

Dissemination of Viruses

Unwittingly man has been the greatest disseminator of plant viruses.

In his efforts to acquire new varieties and species for cultivation, and improve existing varieties, plant material was collected indiscriminately from its natural habitats and spread throughout the world.

Undoubtedly, many of these plants would have acquired, by natural selection, tolerance to viruses native to their regions. When brought into contact with other varieties or species lacking such tolerance, destructive diseases resulted.

Similarly, as he developed new regions for agriculture, cultivated varieties were brought into contact with native species. Concurrently, insects and mites were transported in both directions with their host plants.

A good example of a virus established on a native host attacking an introduced species, is provided by the alfalfa dwarf virus which causes Pierce's disease of grapevines. The virus, which has an extremely wide host-range, and is carried symptomlessly on most of its hosts (Freitag 1951) is leafhopper transmitted.

In California, Pierce's disease has been a killer disease of grapevines since 1892, but it was not recognized in Florida until recently (Stoner 1953). In Florida, however, a long history of failure to grow the European grape, *Vitis vinifera* L., commenced with the Spanish settlement in the sixteenth century. Failure of European grape varieties appeared unaccountable because the native grape, *Vitis simpsonii* Munson, flourished. Stoner (1953) also reports that the West Coast *Vitis labrusca* L. varieties proved unsatisfactory in Florida.

It is now believed in California that the virus was introduced into the southern part of the State by migrants from the Mississippi Valley (Missouri) region, where the disease is endemic.

Positive evidence of the country of origin of a virus is rarely possible because the varieties are now so intermixed. However, strong evidence of the country of origin of the beet curly top virus was obtained recently by Bennett and Tanrisever (1957), when curly top disease symptoms were produced in the United States on plants inoculated from dried leaf specimens collected in Turkey. This evidence is supported by the fact that the only known vector of the virus, the leafhopper *Circulifer tenellus* Baker, is a native of the Mediterranean region. Curly top has been the principal disease of sugar beet in western United States, since 1899.

Do we have native plant viruses in Australia? This question is often asked and, as might be expected, is not easy to answer. In regard to aphid transmitted viruses the answer is that practically all recognized viruses have been identified with viruses which occur elsewhere in the world. Moreover, all the aphid vectors of these viruses are introduced species, as only one or two indigenous species of aphids have been recognized in Australia.

Aphid transmitted viruses first reported in Australia but now known to occur overseas include banana bunchy top virus (Magee 1927) and carrot motley dwarf virus (Stubbs 1948). Subterranean clover stunt virus (Grylls 1956) and broad bean wilt virus (Stubbs 1947) have not yet been recognized elsewhere, although the latter is suspected to occur in Hawaii (Sakimura—personal communication).

An unequivocal answer cannot be given for leafhopper transmitted viruses. Tomato big bud (Samuel *et al.* 1933) and tobacco yellow dwarf viruses (Hill 1937), first described in Australia, are grouped by Smith (1957) with the North American cranberry false blossom virus, because of symptom similarities on common hosts.

On the other hand, Helms (1957), reporting on witches' broom (tomato big bud) viruses on lucerne in Australia, describes symptoms on certain hosts which resemble those attributed to strains of aster yellows virus in North America. She concludes that "there is at present no real basis for distinguishing viruses of the yellows group" and "that little progress will be made—unless parallel experiments are made using the same vectors and host grown under uniform conditions".

A third, apparently distinct, virus, Datura rugose leaf curl (Grylls 1954) is transmitted by the leafhopper, *Austroagallia torrida* Evans. The tomato big bud and tobacco yellow dwarf viruses are transmitted by the leafhopper, *Orosius argentatus* Evans. These constitute the sum total of leafhopper-borne viruses which have been recognized in Australia.

The vector of two of them (*O. argentatus*) also occurs throughout the Australian Region, and as far north as the Philippines, and big-bud disease has been reported from Java and Fiji (Hill and Helson 1949). The possibility exists, therefore, that they also could be foreign introductions.

Although Melbourne, Australia, is generally credited with the first record of the tomato spotted wilt virus (Samuel *et al.* 1933; Smith 1957), Sakimura (1947), in a comprehensive review of the thrips vectors of this virus, refers to an earlier record on tobacco, (1906) by Lounsbury, in the Union of South Africa. Moreover, the sudden appearance of the disease in Melbourne suggests an introduction, possibly on one of the African native species grown as ornamentals in home-gardens.

This seems even more likely when considered with the evidence that one of the thrips vectors in Australia, was incorrectly identified as *Frankliniella insularis* Frank. and is now known to be the South African *F. schultzei* (Tryb.) (Sakimura 1947; 1956). The other vector, *Thrips tabaci* Lind. occurs in most countries.

Rose wilt (dieback) virus disease (Grieve 1931) has not been positively identified outside Australia, although Smith (1957) draws attention to a similar disease in Italy.

Finally, the sugar cane ratoon stunting virus (Hughes and Steindl 1955) first recorded in Queensland, has since been recognized in practically all cane-growing countries.

Hughes (1955) states that "ratoon stunting does not appear to be present in New Guinea which is one of the world focal points of the genus Saccharum". This additional evidence, coupled with the widespread distribution and extensive grass host-range of the virus, suggests that ratoon stunting also is an introduced virus.

The evidence presented above, favouring a foreign origin for most of the plant viruses recorded in Australia, permits further speculation as to whether the native flora which failed to contribute food plants to the world pool also failed to provide viruses (or in fact other pathogens) which attack them.

However, little is known about the reactions of native flora to introduced viruses, and an investigation of genera which are characteristically Australian could be very rewarding—particularly if they were found to be non-susceptible to viruses, or were subject to native viruses.

Nomenclature and Classification of Viruses

From the pioneer workers, whose training was along mycological or bacteriological lines, we inherited the quaint and rather trivial virus names—the innumerable mosaics, yellows and dwarfs usually linked with the common names of the hosts on which the viruses were first identified.

These names have been retained and added to in spite of their crudity, because virologists find little difficulty in remembering names like aster yellows and cucumber mosaic.

The Latin binomial system of nomenclature and classification prematurely introduced by Holmes (1939) failed to gain majority support from plant virologists, because most realized that too little was known about the nature of viruses to warrant straining their memories to substitute, for example, *Chlorogenus callistephi* and *Marmor cucumeris* for the above common names.

Their stand was supported at the International Microbiological Conference held in Rome in September, 1953, where the Virus Sub-Committee of the International Nomenclature Committee discouraged the use of classification systems and binomals until more was known about the viruses and their relationships.

However, study groups concerned with the better known and more intensively investigated groups of animal viruses were instructed to prepare descriptions of certain virus groups and group members for publication. This has since been done with the Myxovirus (Andrews *et al.* 1955), Poliovirus (von Magnus *et al.* 1955) and Poxvirus (Fenner and Burnet 1957) groups.

When more is known of the morphology, serological relationships and chemistry of plant viruses, they also will be classified and named in related groups.

Morphology, Chemistry and Structure of Plant Viruses

It is beyond the scope of this article to review all developments which have occurred since Stanley (1935) succeeded in purifying the tobacco mosaic virus (TMV), and Bawden and Pirie (1937) made the important discovery that TMV was a nucleoprotein containing ribonucleic acid (RNA).

However, no general article on viruses would be complete without passing reference to some of the highlights in physico-chemical developments during the intervening period, which have so greatly advanced our knowledge of virus entities.

The electron microscope, and determinations made from X-ray diffraction patterns, have revealed the size, shape and, to a large extent, the structure of a number of viruses.

With few exceptions plant viruses appear in electron micrographs as rods of various lengths which may be stiff or sinuous, or as approximately spherical particles.

The tobacco mosaic virus is a rod of constant width (15 mμ) and much disputed length—280 or 300 mμ being the most frequent measurements. From X-ray investigations by Franklin (1955) and others, the virus particle is conceived to have an outer helix of protein and an inner structure of RNA. The virus contains 6 per cent. by weight of RNA and its molecular weight is 50 million.

Electronmicrographs of partially degraded TMV prepared by Schramm *et al.* (1955)

show protein discs with a hole in the centre of each disc, or discs strung on a central RNA core. Partial degradation was accomplished by treatment of the virus at pH 10.3 followed by electrophoresis fractionation.

The smallest 'spherical' plant virus, having a diameter of 16 mμ, approaches the size of protein molecules in normal healthy plants.

In 1955, Fraenkel-Conrat and Williams reported reconstitution of active virus from chemically separated protein and RNA components of TMV, which were individually non-infective. The reconstituted 'virus' consisted of nucleoprotein rods with the same serological and chemical properties as the native virus. It was also claimed that the infectivity of the 'restored' virus was about 2 per cent. of the native virus.

Later, however, Gierer and Schramm (1956) found that RNA alone, when extracted by a phenol treatment, transiently retained about 2 per cent. of the infectivity of native TMV, and their findings have since been confirmed by Fraenkel-Conrat and others.

The importance of deoxyribonucleic acid (DNA) within living animal cells has long been realized and Watson and Crick (1953) state that it is "the carrier of part of (if not all) the genetic specificity of the chromosomes and thus of the gene itself". Fraenkel-Conrat (1956) demonstrated the importance of RNA in TMV self-duplication, when he polymerized the protein of one strain of virus with the RNA of a different strain. The hybrid TMV possessed the immunological properties of the strain which supplied the protein, and induced disease symptoms characteristic of the strain which supplied RNA.

Recently, Cochran *et al.* (1957) using chromatographic techniques, reported the presence of an RNA fraction with infectivity several times greater than that of a nucleoprotein fraction, in tobacco plants nine days after inoculation with TMV. In six month old infections, the infectivity of the nucleoprotein component appeared to be several hundred fold greater than that of the RNA fraction. The authors interpret these results as evidence of a RNA developmental stage in virus synthesis and postulate that some 'viruses' may even exist in the RNA state.

A further interesting development has been reported by Tenenbaum (1957), who studied the development of poliomyelitis virus in monolayers of monkey kidney cells under a fluorescent microscope. A sequence of events was observed which culminated in migration of nuclear DNA to the cytoplasm, which suggested the possibility that viruses containing RNA might have an intercellular DNA phase. As poliovirus strains resemble plant viruses in that they contain RNA instead of DNA, this discovery could be another important link in the chain of knowledge on virus synthesis.

As the early discoveries on the chemistry of plant viruses led to similar developments in regard to animal viruses, no virologist, whether he be interested in plants or animals, can now afford to neglect events occurring in the whole wide field of virology.

It is understandable, but unfortunate, that most of the detailed work on the chemistry of viruses has been done with such an a-typical virus as the tobacco mosaic virus. This highly stable chemist's delight, is a paradox in that it is extremely infectious, but is not transmitted by sucking insects.

Viruses which have a complex relationship with their vectors, particularly those which multiply in both plant and insect (vector) tissues and, therefore, qualify as both plant and animal viruses (Maramorosch 1958), are difficult subjects for chemical investigation. They do, however, include many of the most important and destructive plant viruses known to man.

Further knowledge of the pattern of virus synthesis in plant and animal tissues, along the lines of that presented by Cochran *et al.* (1957) and Tenenbaum (1957), should greatly assist vector specialists in interpreting the still mysterious mechanisms of transmission of viruses by arthropods and may lead to their control by chemical methods.

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THE HISTORY, CHARACTERISTICS AND POTENTIAL OF CLARE SUBTERRANEAN CLOVER

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Recent field performance of the Clare strain of subterranean clover (*Trifolium subterraneum* L.) suggests that it will play an increasingly important part in the agriculture of Southern Australia. It seems worthwhile, therefore, to place on record the known history of this strain and to describe its most important features.

History in South Australia

Attention was first drawn to this clover by the late J. E. Butler, a farmer of Clare, South Australia. Mr. Butler sought to have the strain identified in 1941, stating that it had been present on his property for about 20 years, that it appeared to be more vigorous than the Mt. Barker strain and that it appeared to be spreading.

Specimens were forwarded to the Waite Agricultural Research Institute in 1941 and in the following year seed was obtained and planted in seed boxes with a view to identifying the strain.

From examination of the plants by one of the authors (C.A.N-S.) it was concluded that they did not resemble any previously described strain. The behaviour of the plants in the grass garden, in particular their vigorous early growth, seemed sufficiently promising to warrant the naming of the strain. Following the convention of applying the name of the area in which a sub. clover was first recognised as a distinct strain, it was called "Clare". The rainfall of this centre is 24.41 inches with a mean effective growing season of 7.7 months (Trumble 1945) and the soil is a red-brown earth.

Following seed increase in the Waite Agricultural Research Institute grass garden in 1943, sufficient seed was available for preliminary sward trials in comparison with other strains in 1944. In 1947, to obtain a supply of seed for more extensive trials, the bulk of the seed then available was given to Mr J. E. Becker, a farmer who specialised in the production of pasture seeds. A small area was sown at Keith, S.A., in that year and produced enough seed to sow an area of some 120 acres in 1949. This stand was the first area of Clare subterranean clover to be grown on a commercial basis and to be registered under the South Australian seed certification scheme. Nearly 5 tons of seed were paddock-sealed from the machine in the 1950-51 season.

The total area of Clare subterranean clover registered each year for certification in South Australia has varied over the period 1954-57 from 100 to 500 acres. In 1955-56 registration was applied for for 320 acres but less than 100 acres were of the required standard of strain purity.

Principal Characteristics

The Clare strain possesses a number of morphological characteristics by which it may be

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Figure 1—Clare subterranean clover showing leaf growth and the characteristic markings of each leaflet.

readily distinguished from the other commercial strains, Dwalganup, Yarloop, Bacchus Marsh, Mt. Barker, and Tallarook.

The pattern of the leaf markings is very characteristic with each leaflet commonly displaying a deep chocolate brown colour in the basal sector, above which is a prominent central crescent, greenish cream in colour and attaining a width of 3/16 in. On either side of the crescent two white bands extend to the edge of the leaflet. The crescent is surmounted by a further area of dark chocolate brown colour. The presence of leaf markings and the intensity of the crescent are dependent upon low temperatures. Late in the season the brown markings may be very much less intense or absent. The stipules are characterized by red blotches.

The leaflets are relatively large, often attaining a width of 1 in. or over with a length of ¾ in. or more (Figure 1) and the petioles are correspondingly long. Fewer leaves are normally developed than in the commercial mid-season and late maturing strains while the stems are frequently reddish in colour and very sparsely hairy.

The seeds of Clare subterranean clover, which are of the typical purplish black colour, differ in shape from the ovoid seeds of other strains. The seeds of the Clare strain are longer than they are broad and are laterally compressed and often depressed in the centre, particularly when conditions have been unfavourable during the maturation period. The seeds are also distinctly larger with an average number per pound of 35-45 thousand. The corresponding figure in the Yarloop strain is approximately 50 thousand and this compares with a wide range of between 60 and 85 thousand in samples of the other commercial strains. A comparison of the seed of the Clare and Mt. Barker strains is shown in Figure 2.

The corolla of the flower is white without red markings or bandings. The seed pod (burr) is much larger and the stiffened calyxes of the sterile flower are harsher and more prominent than in the other strains. Their prickly nature causes the burrs to cling strongly together in clusters.

The Clare strain also possesses a number of physiological characteristics which differentiate it from other commercial strains.

In time of flowering and maturity in South Australia it is very similar to the Bacchus Marsh strain, but this characteristic appears to fluctuate somewhat with location so that it may be either a little earlier or later than the latter strain.

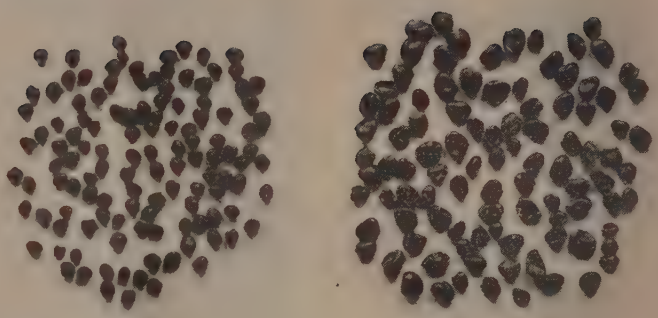

Figure 2—Comparison of seed size and shape in two strains of subterranean clover, left: Mt. Barker, right: Clare.

It has been shown (Morley and Davern 1956) to have no cold requirement for flowering even when grown under glasshouse conditions during the summer months. In this respect it resembles Dwalganup and Yarloop and differs from Bacchus Marsh, Mt. Barker and Tallarook. This suggests that the later flower initiation of Clare as compared with Dwalganup (Aitken 1955) is due to a difference in photoperiod requirement, although more recent work (Morley and Evans) has emphasized the importance of temperature by revealing that the late flowering of Clare in cold climates is due to inhibition of initiation by low temperatures.

The Clare strain does not hybridize readily with the Bacchus Marsh, Mt. Barker and Tallarook strains, a high degree of sterility being evident in the F_1 generation of each of the hybrids. (Morley, Brock and Davern 1956). Highly fertile hybrids were obtained however, when Clare and Wenigup strains were crossed (Morley 1956, private communication).

The Clare strain exhibits a complete lack of seed dormancy at temperatures below 30°C (Morley, private communication) and it is thus adapted to germination and vigorous development either where rain falls early in the growing season or where moisture can be made available through irrigation.

The Clare strain has exhibited a degree of frost susceptibility and this was particularly evident in the winter of 1958 in some areas of South-Eastern Australia which had experienced unfavourable climatic conditions during the preceding autumn.

When grown in Canberra, the general characteristics of the Clare strain resemble most closely those of lines collected and introduced from the low elevation and near coastal areas of Morocco.

A characteristic of the Clare strain is the relatively rapid initial growth of an individual plant. In swards, provided the plant population in each is comparable, Clare attains a higher level of production early in the season than the other commercial strains. (Figure 3.)

Recent work (Black 1957) showed that this superior early development was highly correlated with seed size. The significance of temperature in the early growth of Clare and of four other varieties has been shown by Morley (1958). At a mean temperature of 24.2°C Clare exhibited superior development to Bacchus Marsh to the end of the experimental period of 27 days while at a mean temperature of 16.8°C the reverse was the case.

Agricultural Potential

The earliest sward trials in which Clare subterranean clover was included were started in

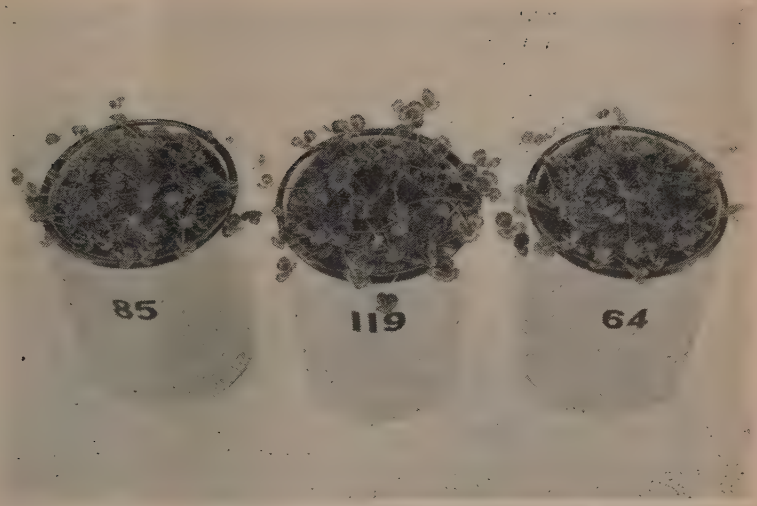

Figure 3—Comparison of early vegetative development in three strains of subterranean clover, left: Mt. Barker, centre: Clare, right: Bacchus Marsh.

1944 by one of the authors (C.A.N-S.) and concluded by the other (A.J.K.W.) at two sites in the Southern Adelaide Hills district where the mean annual rainfall is about 30 inches.

The Clare strain generally produced less total dry matter than either Mt. Barker or Tallarook, which have a longer period of growth. Clare was the outstanding strain, however, in the production of early winter forage. More recent work (Higgs, private communication) shows clearly that later strains like Mt. Barker and Tallarook usually yield more than Clare if the season is long enough to allow them to complete their full growth period.

In South Australia it is unlikely that Clare will be sown extensively in districts where the annual rainfall exceeds 24 inches but there may be a place for Clare in these areas in special pastures for early winter feed. The areas in which the strain may be used extensively are those between the 16 and 22 inch isohyets, which lie within the effective growing season period of 6.0-7.5 months (Trumble 1937). In other areas, however, with a different temperature and rainfall regime, e.g., the North Coast of New South Wales, Clare has been the outstanding strain under a mean annual rainfall of 54 inches (Arthur and Jenkins 1956).

Bacchus Marsh has been the most popular strain in these areas and comparisons between the two are therefore of interest. There was no marked difference between the total yield of the two strains in two trials at the Waite Institute from 1949 to 1955. Bacchus Marsh was higher yielding than Clare in the first trial but lower in the second. (D. Symon, private communication.) These trials were conducted on a red brown earth soil and Department of Agriculture trials on similar soils have given results in general agreement with those from the Waite Institute.

Two factors, high soil pH and severe weed competition, have exerted a marked effect on the relative performance of these two strains.

Field trials and observations made on farm sowings show that Clare is more productive than Bacchus Marsh on alkaline soils. This difference is associated, in part at least, with trace element nutrition for the Clare strain, unlike Bacchus Marsh, shows little response to added zinc or manganese on soils of high pH (Higgs 1958). There is a large area of alkaline soils in the cereal district north of Adelaide in a rainfall zone favourable for Clare subterranean clover. Some *Medicago* species, e.g., Snail medic (*M. scutellata* (L.) Mill.) are capable of high yields on these soils but their regeneration in the second and subsequent years is often very poor. Yield and

botanical composition of the pasture may therefore vary widely from year to year. Regeneration of Clare subterranean clover is more reliable and there is less yearly fluctuation in yield and composition.

The rapid early growth of Clare enables it to compete more effectively against weeds than does Bacchus Marsh. This has been demonstrated well on land infested with soursob (*Oxalis pes-caprae* L.). In the presence of a soursob leaf canopy, Bacchus Marsh is seriously checked by shading for several weeks after germination, but Clare is able to maintain a large leaf area above the canopy.

This advantage of Clare over Bacchus Marsh can be nullified by periodic close mowing and there is, in fact, some indication that Bacchus Marsh recovers better than Clare. (Higgs 1957, private communication). Under farm conditions, however, pastures are seldom grazed so closely as to achieve the effects of close mowing, and the rapid early growth of Clare is likely to prove an important factor on land badly infested with weeds.

Clare therefore appears superior to Bacchus Marsh on alkaline soils or weedy land in the 16 to 22 inch rainfall zone. Little difference in yield would be expected on other soils in this zone and further trials are needed to establish whether Bacchus Marsh is significantly better than Clare in recovery after grazing.

The supply of Clare seed has been limited to some extent by the difficulty in threshing the large, fibrous burrs, and the unusual size and shape of the Clare subterranean clover seed make it more difficult to clean to the first-grade standard of purity. As a result only a small proportion of the seed harvested has been sealed and sold as certified seed.

The effect of these factors is reflected in the present high seed price and would tend to restrict the use of Clare subterranean clover to areas where its superiority over other strains has been proved.

Interstate and farmer-to-farmer sales of uncertified seed prevent an accurate assessment of the total seed harvest but with probable yields of 1-1½ cwt per acre, the mean annual production over the last few years would be of the order of 20 tons.

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Articles

FARM MANAGEMENT CLUBS FOR AUSTRALIA

H. P. SCHAPPER

The Brunswick and Districts Rural Advisory Service in Western Australia, and the Bombala Rural Advisory Service in New South Wales are the first farm management clubs to be formed in Australia. Their establishment marks the beginning of what is expected to be yet another self-help movement by Australian farmers.

It is a normal function of farmers to be the changers and improvers of their physical environment. They also change and improve their institutional, political and economic environments. In 1905 about 200 farmers in Western Australia co-operated in a joint wheat marketing venture, and forced millers to raise their price to all farmers by threepence a bushel. In the early 1930's bulk handling of wheat was effected through the concerted efforts of farmers and of farmers' companies. It is reported to have netted more than £4,000,000 in reduced costs in one State alone, in under 20 years. In 1945 the Farmers' Union of Western Australia was established and continues to be a strong institutional force in farming affairs. Finally, in 1954 the wheat growers of Western Australia voluntarily levied themselves to finance some major research undertakings at the University Institute of Agriculture. There are many further examples of farmer self-help and farmer co-operation which, often after long struggles, have brought improvements to rural transport, to agricultural marketing and to farm price policies.

The purpose of this article is to give details of another improvement that farmers in Australia can bring about through self-help and co-operation. By establishing farm management clubs farmers can, at low cost, purchase for themselves a technical and managerial advisory service which experience elsewhere has shown to be highly profitable whatever the costs and prices of the things which farmers buy and sell.

To be successful the club idea must be developed by farmers. Before discussing the nature and details of a farm management club it may be useful to highlight a number of important features in the Australian farming tradition which, when considered together, suggest the existence of an environment already favourable for the rapid expansion of the farm management club movement.

Need for Technical Services Recognised

Farmers in Australia have long recognised the value of the findings from agricultural research and of the need to be kept informed of them by qualified and reliable advisers. Just how highly they value the existing research and advisory services may be illustrated in a number of ways. There are large attendances at field days run by Departments of Agriculture; there is the concern, expressed at meetings of numerous branches and of the executives of Farmers' Unions, at the loss of agricultural scientists from Departments of Agriculture and at their relatively low salaries, and there is the establishment by farmers of scholarships for students of agricultural science. This is clear evidence of recognition by farmers that the existing services are valuable, and inadequate.

In addition to recognizing the value of technical research and advice, farmers are now becoming aware of a further need. This is the

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need to combine technical advice with economic considerations. Increasingly, farming is a business. An idea which is now gaining widespread acceptance is that the business value of technical advice can be increased many-fold when it is combined with the methods of thinking that characterise the farm management expert.

Business Management and Farm Management

In recent decades throughout the industrial and commercial world in western countries, there has arisen a new profession. It is that of business consultation and administration. The services provided by the members of this profession are directed towards helping the managers and directors of firms and companies to make better decisions within their own business. They deal with the selection and organization of staff and labour; the design and use of records and cost accounts; systems of financial control; flows of raw materials and goods in process; the dissemination of information, and so on. The purpose of all this activity is to help business men get more and more out of their limited financial, labour and machine resources, not by extortion and exploitation but through improvements in organization and better combinations of men, materials and machines. To get more, in this way, out of existing resources is what is meant by increasing efficiency or improving productivity.

Persons trained as business administrators or as consultants are now the product of university and technical schools of business administration. Their services are hired by directors and managers with long practical experience, who find it highly profitable to purchase these services and to combine them with their own experience. The extra income that derives from the advice of the consultants more than compensates for their fees.

The technical and economic problems faced by farmers are no less complicated than, nor greatly different from, those faced by the board of management of a large industrial firm. The difference is that the individual farmer's problems are much smaller with respect to the nation's total resources. On the other hand if the farmer makes a serious mistake the financial security and economic livelihood of his whole family is endangered, whereas if the board of management makes an error the personal loss to the managers themselves is not likely to be so serious.

Many universities throughout the world have now recognised the need to give agricultural science students the opportunity to become qualified to assist farmers to arrive at better economic decisions about their own farms. Training is no longer confined to the biological and physical sciences but includes some of the social sciences such as economics, sociology and farm management. From this shift in emphasis within the universities there has emerged a distinct tendency, in government information services for farmers, to recognize the differences between technical information on the one hand and economic thinking on the other.

Technical Information and Economic Thinking

University and government departments of agriculture throughout the world annually spend large sums breeding new and better plants and animals, increasing crop, pasture and livestock yields by the control of diseases and pests and by better nutrition, and discovering cheaper ways of obtaining the world's food, and fibre supplies. These discoveries are brought to the attention of farmers by governmental and private information services using a wide range of media including radio, journals, field days and farm visits. Until comparatively recently these information services have tended to concentrate on informing farmers on how to do things, and on what to do to raise yields and to reduce deaths of plants and animals. For the dissemination of this technical information Departments of Agriculture and other institutions have relied on methods of mass communication. These methods constitute the way in which the limited numbers of the advisory personel provided by governments can be most effective. But for as long as advisory personel employed by governments remain at anywhere near their present numbers, i.e., at a ratio of one advisory officer per 300 to 1,000 farms, it is unlikely that there will be any substantial departure from either the present methods or the content of existing advisory services.

Farmers must know more than just what to do and how to do it. To achieve maximum economic efficiency or highest possible nett income, farmers must also know in what ways to combine their land, labour, machinery, and other resources. They must also know at what levels to apply feeds and fertilizers, what adjustments to make to changes in relative costs and prices and to falling income, at what levels of soil fertility to farm the land, and so on. To make the best possible decisions in the light of these changes, farmers require not only technical information on varieties, weedicides, insecticides and fertilizers but also a working knowledge of the tools of economic thinking. Using these tools, advisers are able to relate the findings of research to a particular set of farm resources. In this way the farmer can become more certain (it is not wise to be absolutely certain in economics or farm management) that, in the face of the continuous flow of new findings from research and of the constant changes in prices and costs, his nett income is the highest possible from his area of land using his labour and machinery with his financial limitations. It is commonplace on Australian farms to find high levels of technical competence, knowledge and skills going unrewarded financially because farmers do not have these tools of management nor do they sufficiently appreciate the difference between technical information and economic thinking.

Farms and farmers differ in many respects, e.g. in area, soils, indebtedness, labour force, personal skills, security-mindedness, technical knowledge, risk taking, etc. It is therefore unwise to rely upon mass communication methods for advising farmers of the complicated profitable investment opportunities on their own farms, of profitable reorganization or of income-earning changes in operation. To advise farmers about these opportunities requires an intimate knowledge of the particular farm, the farmer and his resources which it is not physically possible to obtain with the present adviser farm ratio of one to 300-1000. This fact has been recognised in some countries, where many farmers have organized a management advisory service, in which the adviser farm ratio is one to about 50-80.

Importance of Higher Farm Nett Income

Before focusing attention on to farm management clubs some points about nett income should be made. Often farm management advisers are accused of being too money-conscious and of forgetting that farming is also a way of life. It is true that the farm management adviser does think and speak in terms of profitability and regards it as his function to give farmers ideas and information from which they may be able to make the highest income-earning decisions. For this he makes no apology and is inclined to the view that the more efficient the farmer the higher will be his nett income and the more readily he will be able to achieve his way of life goals. The expansion of the farm, repayment of debt, increase in the value of the property or of savings, improvements in the home, secondary and university education for the children, and increased holiday and leisure time are way of life goals and income goals that may be achieved and reconciled more readily and least painfully through improvement in nett income.

Farm Management Advice

The value of farm management advice can best be appreciated from examples. A spectacular illustration comes from America where 24 dairy farms were selected for matching into 12 even pairs. During a period of six years from 1946 to 1952 one of each pair was given farm management advice. The other farmer was left to himself, although he had access to the standard technical advisory services of his district. The differences between the twelve farms which received farm management advice and the twelve which did not, are shown in Table 1. The table is self explanatory, but one point from it is worth making. It shows that unaided by farm management advice the control farms increased their production of milk by 10,500 lb per farm and by 17,861 lb per man. Despite these improvements, the nett income of these farms fell by an average sum of $1110. Clearly, the price of milk must have fallen and/or the costs of producing it must have risen. In fact, both happened, but the 12 farms receiving the farm management advice bought and sold at the same costs and prices

as did the other 12, and yet they increased their nett incomes by $1370 during the same period. In other words, it appears that for many farmers, rising costs and falling prices need not necessarily result in lower nett incomes. Also, as long as farms are not organized and operated as efficiently as they could be then no matter what the state of the market, nett income before taxation can be increased by some farmers.

Another example comes from New Zealand where in 1954-55 the butterfat payout by some factories was threepence per lb less than in 1953-54. Despite this fall in price the twelve members of the Franklin Farm Improvement Club, for whom records were available for both of these years, averaged an increase in nett profit of £400. At the extremes, one farmer netted only £3 more whereas another netted an additional £890. (Wood 1956).

A final example comes from a study of wheat and sheep farms made in Western Australia (Giles 1950). In this study records for eighteen years, from 1931 to 1948, were reconstructed for a typical wheat and sheep farm. For every year a separate budget was drawn up at the then current costs and prices for each of four different feasible systems of management. These results were compared with the annual nett farm income actually earned by the farmer. Had that farmer adopted any one of these four systems of management for his farm, and without any further capital, he would most probably have been financially much better off at the end of the period than he actually was. Had he chosen the least profitable system he would have been worse off in only six out of the eighteen years and had he selected the most profitable system he would have been better off in every year.

The underlying thing that these and still other examples have in common is that the best services of farm management advisers can only be given on a close and personal basis, not through mass communication methods. For governments to provide such services many more hundreds of university graduates would have to be employed in Departments of Agriculture throughout Australia. That this will come to pass is highly improbable and possibly the best way out is for farmers to form themselves into groups of 50-80, and jointly employ

TABLE 1

Changes in production efficiency and returns, 1946-52, *due to farm management advice.*

Measures of Production Efficiency and Returns	Farms with Management Advice	Control Farms
No. of cows	+ 4	— 1
Production per farm (4% milk)	+ 62,500 lb	+ 10,500 lb
Production per cow (4% milk)	+ 1,017 lb	+ 546 lb
Grain fed per cow	+ 20 lb	— 135 lb
Men per farm	From 2.4 to 2.0	From 2.1 to 1.9
Production per man (4% milk)	+ 37,886 lb	+ 17, 861 lb
Acres used per farm	+ 26 ac	+ 11 ac
Nett income in 1946 dollars		
1946	$3050	$3870
1952	$4420	$2760
	+ $1370 or	— $1110 or
	+ 52%	— 29%

Source: Wheeler & Black (1954).

their own farm management advisers, and in this way set up the demand that promises to create the supply of the requisite graduates.

Farm Management Club and Its Formation

A farm management club generally consists of about fifty farmers, legally bound to one another to jointly employ a professional adviser whose job it is to help individual members of the club to increase their nett farm income through better decision-making. The farmer members pay the adviser's salary, superannuation, and expenses incurred in travelling from farm to farm. They also provide him with office accommodation and secretarial assistance where necessary.

The adviser of a farm management club should be a university graduate in agricultural science or in agricultural economics. He should have had experience in the type of farming practised by the group he is going to advise and he would have to be a person of maturity and considerable ability. He would require a salary and superannuation competitive with current rates of professional pay. In addition £500 per annum would have to be earmarked for travelling expenses. A group of farmers would have to think in terms of raising £3,000 to £3,500 per adviser per annum for a minimum period of three years before they could regard the club as financially established. This would amount to about £60 per farmer per year. Once a suitable person has been appointed he would normally require a further 3-6 months study and training on full salary which can best be done at a university. During this time he would orientate himself to the problems of the particular district in which he will be employed.

The first task of the club's adviser would be to study each member's farm. He would make himself a sketch plan showing the cropping, fertilizer and yield history of each paddock. He would acquaint himself with each farmer's own farming practices and ideas and he would also want to know the nett farm income of the last few years. With all of this information he and each farmer together would draw up several estimates or budgets of the financial outcome of several likely plans and reorganizations. In addition the adviser would hold a number of indoor and outdoor field days for club members on subjects of topical importance.

He may also organize a farm recording scheme for members. These schemes are common in the U.S.A. In Western Australia a firm of accountants and the University Institute of Agriculture have jointly and successfully organized a similar scheme for several districts. In the hands of farm management advisers the information from such records constitutes an additional tool which can bring about substantial improvements in bank balances, cost reductions and in managerial efficiency generally.

The actual formation of farm management clubs is something that farmers must do for themselves. The idea must be spread by farmers. They will have to organise their own executive committees and so on. But there are already two clubs in Australia which have surmounted all the difficulties preceding their formation, and members of their executive committees and of the clubs will be able to help and encourage other groups of farmers desirous of setting up similar clubs. In the short run there will be difficulties in obtaining suitable farm management advisers. In the long run, there is little doubt that an effective demand created by farmers will induce capable young men to undertake the training necessary for these new positions.

A Laboratory for Farm Management Clubs

It may be argued that club advisers need rely only on existing institutions such as C.S.I.R.O. and Departments of Agriculture for their research information. These institutions will always be a primary and major source of technical information for club advisers. But advisers will need also to make budgetary analyses. The optimal solutions for typical farm resource situations provided by linear programme analyses are another valuable aid to farm advisers. These can be determined only in a laboratory. However, advisers can get a long way merely with comparative budgeting.

An alleged drawback of the farm management club is that the adviser has no roots in his profession in the sense that he is cut off from the specialists who would normally come to his aid if he was an employee in a Department of Agriculture. But this is not quite the

position. The services of Departments of Agriculture are public services and one of the functions of the club adviser will be to draw the attention of other experts in C.S.I.R.O., Departments of Agriculture and universities to the problems which he cannot solve.

Nevertheless, it would be an advantage for the farm management advisers to be served by a central farm management laboratory. The major function of this laboratory would be to service the club advisers (not the members directly) and individual farmers who do not have an opportunity to join a club, with the results of farm management research and with information of specific importance and interest. Research cannot be done by the club adviser nor undertaken by the club because the overhead expenses involved would be too high for the members. It is possible however, and desirable, for a central farm management research laboratory to grow out of a federation of clubs in each State, to cut the overhead costs per group and to maintain a continuous flow of farm management information to the club advisers.

An appropriate place for such a laboratory would be within the precincts of the agricultural faculties of universities. These should be regarded not only as teaching institutions but as growing points of agricultural economics, farm management and technical knowledge. What is envisaged here is that as farm management clubs become established they will also help to establish, and will affiliate with, a laboratory which could be maintained by affiliation fees aud outside funds. This would mean that in the course of time there would be developed an association of clubs centred around a farm management laboratory. These farm management laboratories could develop also as training centres for senior students interested in a farm advisory career and as centres for refresher work by field officers of Departments of Agriculture. After some years of experience in the field, selected officers could profitably spend a refresher year in such a laboratory working out programmes of farm development for their own district, evaluating their own extension work and keeping abreast of developments in operational research.

These laboratories, it is clear, could become centres of development in farm management which, except perhaps in New South Wales, do not exist at the moment in Australia and which may appropiately be developed in partnership by federations of farm management clubs, Departments of Agriculture, the universities and perhaps the Agricultural Research Liaison Section of C.S.I.R.O.

Fitting in with Departments of Agriculture

There is no possibility of farm management clubs competing with the services offered by the State Departments of Agriculture. For this there are several reasons. The services offered are different. The farm management service uses the technical information provided by Departments of Agriculture and other institutions. Where technical problems arise which cannot be answered by the club adviser this adviser will be the first to seek the help of the Department of Agriculture. It is likely that farmer members of farm management clubs will see officers of Departments of Agriculture more than ever before. Usually it takes an expert to recognize a problem and the farm management adviser will cause club members to see problems on their own farms that they now overlook, and in this way stimulate the demand for the services of the State governments. Another reason why these services will not compete is that State governments are never likely to be in the financial position from which they could, even if they were willing, employ the large number of extra advisers required to give the intensive farm management advice and training that many farmers have confessed they would like to have and, it seems, would be prepared to pay for.

It has been thought that it might be better if farmers did not form farm management clubs and so allowed all available University graduates to go into State Departments of Agriculture. There is something to be said for this point of view particularly as Departments of Agriculture throughout Australia are understaffed. However, the argument ignores the possibility that private practice in agricultural advisory work may attract additional students to the study of agricultural science, agricultural economics and farm management. Potential

students, when faced with employment only in a State civil service, may prefer to study another course and so be lost to agriculture altogether. In other words, a strong effective demand for graduates by farm management clubs may be a prerequisite for increasing the supply.

Finally, every club stands only to gain from having the local Department of Agriculture adviser present at executive committee meetings as either a full member or advisory member, ex officio. Provision for this should be part of the constitution of each club.

Training for Farm Management Advisory Work

Farm management advisers require a particularly wide and intensive training which offers a challenge to any able young men who may be interested in advisory work among farmers. Subjects from which a desirable course of study can be undertaken at the University of Western Australia are shown below.

These are the subjects to the end of the fourth year when students normally graduate with a B.Sc.Agric. degree. A fifth or Honours year is also strongly recommended. During this year the student undertakes further detailed study in agricultural economics and farm management and writes a thesis reporting his first attempt at research. Students undertaking this course may rest assured that, for the next few years at least, they will be obtaining an education and training orientated towards the most recent developments in professional agriculture.

The Challenge

Farm management clubs are a challenge to farmers, students and universities. They are a challenge to farmers in the first instance because it is only by their formation that the challenge can be passed on to students and universities. Whether or not these clubs are formed depends entirely on the willingness of farmers. Until they are formed students and universities can only guess at the strength of the demand for graduates with the type of education and training required to staff clubs. Without looking very far ahead, there is room for at least 500 graduates for farm management clubs throughout Australia over and above the expected normal increases in the staff of the Departments of Agriculture. The personnel to man this number of clubs is not available at the moment but it should come into existence soon enough as farmers set up the demand. And once this is done students and universities together will create the supply. In fact, the supply is already on the way. In 1951 the University of Sydney appointed a Reader in Agricultural Economics, and a number of years before this the Western Australian University Institute of Agriculture commenced agricultural economics and farm management work. In 1955 a Senior Lecturer in Agricultural Economics was appointed at Adelaide University and a Professor in this subject was appointed at the University of New England. And now this year the University of Melbourne is appointing a Reader in Agricultural Economics and the Universities of Western Australia and Queensland are looking for Senior Lecturers in the same subject. It is from these places that the flow of graduates suitable for farm management clubs are emerging and will continue to do so if an effective demand is set up and made known.

Subjects in the Biological and Physical Sciences	Agricultural Subjects	Social Science Subjects
Physics I	Climatology	Economics I, II, III
Chemistry I	Agrostology	Agricultural Economics
Botany I, II, III	Agronomy	Farm Management
Zoology I	Animal Production	
Biochemistry	Soil Science	
Physiology	Plant Pathology	
Mathematics I	Entomology	
Geology I		

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ERRATUM

In the List of Members—Vol. 24, *No.* 4, *in the section, Corporate Members, New South Wales Branch, Dr. H. J. Hynes was wrongly listed as Assistant Director, Div. of Science Services, Dept. of Agric., Sydney. The entry should read:— Assistant Director, Department of Agric., Sydney.*

Symposia

AUSTRALIAN AGRICULTURE OF THE FUTURE

During the second half of 1958 the A.C.T. branch of the Australian Institute of Agricultural Science held a series of meetings on the general theme "Australian Agriculture of the Future".

The following reports on the papers presented at these meetings have been prepared, in co-operation with the speakers, by Mr. A. F. Gurnett Smith of the Division of Land Research and Regional Survey, C.S.I.R.O., Canberra.

THE CONTRIBUTION OF SCIENCE TO THE FUTURE OF AGRICULTURE

I. CLUNIES ROSS

The role of science in shaping the future of rural development is primarily one of stimulating precision in agricultural practice. This has been its greatest contribution in the past and inevitably future generations will derive greater benefits still when established and clearly defined scientific principles are brought together and translated into more precise and reliable farm practices.

A prediction such as this is merely an extrapolation from the experience of the past twenty-five years or so. It is perhaps superfluous to remind agricultural scientists of the striking progress that has accrued from research into our native deficiencies in plant nutrients and the increasing definition of the conditions under which those deficiencies occur and can best be made good. In a country so notoriously devoid of soils of high fertility, research on the use of superphosphate and trace elements has brought about a virtual agricultural revolution. No less striking advances have been made in the understanding of animal disease and production problems. Veterinary Science students even thirty years ago supposed that practically all major animal diseases could be seen during a day's visit to a metropolitan abattoir. Today, however, a disease such as pleuro-pneumonia, once commonplace, can rarely be demonstrated to students in southern Australia and intelligent graziers may understand the diagnosis and prevention of diseases that were not even listed in University textbooks of less than a generation ago.

The Need for More Precision

The place of Australia among the world's wheat exporters is due in no small measure to the patience and skill of her plant breeders. Great though their past contribution has been, the impact of plant breeding on agricultural progress will be even greater in the future; traditionally, Australian plant breeders have concentrated on grain-producing plants, but, now that attention is at last being paid to the application of modern methods of genetics and plant breeding to the development of

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new or improved strains of pasture plants, even richer rewards should be realized.

New pesticides and weedicides will continue to be developed but perhaps the major contribution scientists will make in the field of pest control will come from basic biological studies of host-parasitic interactions. All agricultural students are told of the material gain we have received from cactoblastis and myxomatosis, and similar methods of biological control will continue to be of great importance. I am convinced, however, that the biologist will make his most valuable advance in knowledge by revealing in detail and with ever-growing precision the pattern of ecological balance in which plants and animals exist and the circumstances leading to the disturbance of this. A clearer understanding of these matters will lead to more certain means of controlling our pests and diseases.

For as far back as human history goes, irrigation has been an agricultural practice. However, it is only in very modern times that the scientist and engineer have joined forces to add some precision to the ways we use water. We now know something of the many factors — physical, chemical, geological and agronomic—involved in this apparently simple operation. We also know something of the dynamite with which we play. Salted areas in the Murray Valley are monuments to our past ignorance. No better example of the need for still greater precision can be found than exists today in the use of water for agriculture.

Integration of Effort

In the past, rural progress has been largely the result of individual scientific disciplines being applied to the solution of specific problems. From a research planning viewpoint, this approach is inadequate, as the very nature of agriculture involves complex biological interactions. In the future, we should look towards the integration of scientific effort. For instance, soil is still described on a basis of its physical and chemical properties but the only reliable test of its fertility depends on seeing how well plants will grow on it. Active research programmes on plant nutrient requirements are in progress, but the bulk of this work is related to the physiological role of plant nutrients or to *ad hoc* measures for correcting gross deficiencies in the field but too little to a basic understanding of soil, plant and nutrient interactions, and, beyond these, of animal interactions also. Land use planning requires not only the enlargement of knowledge in each specialist field but, above all, the integration of such knowledge into an intelligible whole.

Scope for Development in the North

The development of the enormous agricultural potential of Queensland will be assisted by the previous experience of scientists in southern Australia. But the need to find suitable plants for the northern parts of the continent is greater even than it was in the south where it has been possible to draw on overseas experience of temperate regions. There is a particular need for sub-tropical legumes to play a part comparable to subterranean clover in the south; this will involve plant introduction and breeding under controlled environments and, in addition, agronomic research and the development of efficient nitrogen-fixing bacteria. Similar problems in animal adaptation must be attacked if an animal industry with a high degree of efficiency is to be developed in our wet and dry tropics. Current physiological research on the action of sweat glands, coat shedding and infertility under tropical conditions indicate promising avenues for further work. Again, controlled environment facilities and the integration of different scientific disciplines are needed for rapid progress.

Stimulating our agricultural production is, of course, only part of rural prosperity. Food and fodder conservation are integral requirements for steady and assured progress. Nutritionists and food technologists are needed not only in preparing human food but to determine how best to mitigate the disastrous effects of drought. In addition to a better understanding of how this end can be achieved, we need to determine with greater precision the causes and incidence of fluctuation in market demand.

Hopes for the Future

The key to successful agriculture rests on the integrated efforts not only of scientists but of

extension workers, engineers, economists and specialists from a host of miscellaneous disciplines. As professional agriculturists, we should welcome and encourage this integrated effort. But as human beings we must look beyond the realm of strictly material matters to things of the spirit from which alone can come better understanding between men. If we have not in mind the sociological and even the spiritual goals towards which our technological effort is directed, we may well find our grandiose scientific and technological civilization falling in ruins about us.

Book Review

INFORMATION, DECISION AND ACTION

By F. E. Emery and O. N. Oeser with the assistance of Joan Tully

Melbourne University Press, 1958

This little book is a study of psychological factors and their influence on acceptance of agricultural advice. It is based on a survey of a group of farmers in East Gippsland. The sample taken is just sufficient to allow the psychological theory to be presented with some confidence.

As a first step towards understanding the elements of the social system within which Australian agricultural advisory services work, it represents an extremely valuable contribution. To say more such work is needed in other areas is to take nothing from this pioneering effort.

The reader will find the necessary concentration to negotiate the first few chapters, a mental exercise well worth the effort, and will be amply repaid when the climax is reached in the concluding chapters. Here the authors develop the full implications of their survey and study, and set a pattern of requirements for greater effectiveness in the agricultural advisory services.

In this regard, the work provides factual evidence supporting a number of concepts, the more important of which are that:—

1. Individual contact between advisory officer and farmer on a basis of mutual confidence and trust is an essential pre-requisite to acceptance of advice.
2. Post-primary education is the most powerful agent for creating receptiveness to and adoption of new ideas.
3. The channels of communication of new ideas which connect individual farmers is of no less importance than those connecting farmers with outside sources of new ideas, such as the radio and press.
4. The recognition of the existence of the farmer-influencer or informal group leader ("innovator-influencer") as one who has leadership in skill and competence, and who is followed by others.
5. Farmers of better education, and divorced from tradition (with a high "index of urbanization"), actively seek new knowledge.
6. Those farmers who still gain new knowledge by traditional rules depend on "face-to-face" communication. Such farmers are best met indirectly through the skill and competence leadership of others ("innovator-influencers").
7. The most fruitful direct contact work between advisory officer and farmer is with the innovator-influencers—work on the "influencer" so that, indirectly, those with a low "index of urbanization" will be met.
8. The right relationship between advisory officer and the farming community implies close integration of interests and a two way traffic of ideas, so that results of research flow out and new needs flow back.

The study is a splendid factual contribution which will give a new confidence and impetus to the proper development of the Australian agricultural advisory services. It is worthy of careful study by all who are interested in extension work.

A. R. CALLAGHAN

ATOMIC ENERGY AND AGRICULTURE FOR THE FUTURE

J. P. BAXTER

Atomic energy is without question the major discovery of the modern age. While its greatest impact has been on secondary industry its contribution to agricultural research and development should rapidly increase. For instance atomic energy may reduce the cost of electricity in isolated centres of population. The value of radioactive isotopes as a tool for agricultural research is already well known. In the near future research workers will be able to obtain these materials from the Australian Atomic Energy Commission's reactor at Lucas Heights.

Power

Industrial power, based on the atom, is a reality in the United Kingdom, United States of America, France and Russia. In the United Kingdom where coal supplies are limited, several atomic power stations are operating and an atomic generation capacity of about 6,000 megawatts will be attained by 1965. This figure is roughly twice the capacity of all generating plants in Australia at the present time. In America where alternative fuels are freely available, one large power station has been completed, and emphasis is being given to research on the generation of atomic power in a variety of ways. Four atomic power stations are being built in France and in the U.S.S.R., as far as we know, a substantial installation is proceeding. Canada, Japan, Western Germany and Italy are planning to have atomic power stations. India, Holland, Belgium, Norway, Sweden, Denmark and some of the Iron Curtain countries are very actively engaged in atomic research.

Most of the developmental work is directed towards the production of large blocks of power for secondary industry. Generally speaking, the larger the power reactor, the cheaper the production costs. An advantage of atomic power generation in remote areas is that transport of fuel is not a problem.

Small atomic stations, producing from five to fifty megawatts, would suit the needs of rural Australia. This type of power station could be built at the present time but its high capital cost and dependence on special varieties of highly concentrated fuel so far have prevented any extensive development. As the fuel would have to be imported, it has little advantage over the use of oil at the present time.

In an atomic power station of 15 megawatts, the cost of electricity might at present be in the vicinity of 2d. to 2½d. per kilowatt hour. Atomic power generation at this price is not particularly attractive, especially when it is remembered that an atomic power station of this size might cost £1 million. However, the capital cost of these stations will fall within the next decade.

Large stations can use cheaper atomic fuels. Some atomic power stations being built in the United Kingdom for heavy industry can produce power for less than 0.8d. (Australian) per kilowatt hour. In comparison, power can be produced on the New South Wales coalfields for 0.6d. and in Victoria, from brown coal for 0.5d. per kilowatt hour. In England

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the development of power reactors has, of course, been stimulated by the shortage of coal.

The current research programme of the Australian Atomic Energy Commission is directed mainly towards the development of a small high-temperature, gas-cooled reactor which should produce power at an economic rate. If this work succeeds, power for domestic purposes in the country should become a reality.

Radioactive Isotopes

Radioactive isotopes of most atoms can now be made, some of which give off beta rays of low penetrating power and others gamma rays of high penetrating power. A range of these will be available in the near future from the reactor at Lucas Heights and the uses to which they can be put should grow rapidly, especially in relation to agricultural research.

For instance, in Great Britain difficulty was experienced in making sure that small amounts of manganese were mixed evenly in a certain stock food. By adding an even smaller proportion of a radioactive isotope of manganese, a simple check on each bag of product, by its radioactivity, was facilitated. The residual isotope decayed rapidly.

The biochemistry of fatty acids of a variety of carbon chain lengths as contributors to the formation of milk constituents has been studied by using this new research tool. Isotopes have been used in measuring thyroid activity as an indicator of an animal's ability to stand warm climates.

It was generally believed that chickens could not utilise inorganic sulphur. By using S^{35} it was shown that chickens do absorb inorganic sulphur from their diet and increases in growth were shown to result from adding inorganic sulphur to rations.

Isotopes have been used extensively in studying the action of insecticides and there appears to be scope for much more work of this type.

The physiological reactions of animals eating plants treated with insecticides have been studied by using isotopes. For example Parathion labelled with P^{32} has been used to assess the fate of this insecticide in cattle eating treated grass.

One dramatic example of an entomological application of radioactive isotopes relates to the eradication of the screw-worm fly from a small West Indian island. It was known that the females of this insect copulate only once, so males were sterilised by radiation and released. The fly was eradicated and the technique is now being extended to the American mainland.

A Source of Intense Radiation

Massive doses of radiation are now available for use in agricultural research. For example Co^{60} can be produced in thousands of curies fairly cheaply and fission products offer another and even cheaper source. A number of useful mutations have been produced already by exposure to radiation of such plants as wheat, oats, flax and rye. Dwarf strains of cereal crops with strong stems have been produced in this way and the toxicity of some fodder plants may be reduced by breeding work based on induced mutations.

Gamma radiation is being used for preserving food. Unfortunately chemical changes take place as the material is treated. For example, steak treated with sufficient gamma rays and kept sterile will keep indefinitely, but taste and colour changes reduce its palatability. Partial sterilization offers greater promise. The shelf life of refrigerated meat can be extended up to three times the normal by a moderate dose of gamma radiation. The same technique has been used to add to the life of bacon of a fairly low salt content. Research in this field is being done in Sydney at the University of New South Wales.

Gamma radiation is being used successfully for sterilizing anti-biotics.

The dosage of gamma radiation required to kill insects has been found to be much less than that required for micro-organisms and dried fruit, chocolates and other products of this type may benefit from radiation treatment.

Water Supplies

If atomic power stations are to be run efficiently a steady load is necessary. In Great Britain consideration is being given to pro-

viding right load by pumping water to elevated reservoirs in the off peak period and running it through turbines to a lower level during the day. In Australia, in the future, the pumping of water over considerable distances for domestic or agricultural purposes may be economic as an off-peak operation.

The really big atomic reactor will in future provide the cheapest source of heat available to man, and any large-scale development in de-salting of water will probably be based on this source of energy. At present, there appears to be no way of doing this at reasonable cost, but it cannot be ruled out as impracticable for the future. If the problems of hydrogen fusion as a source of power are overcome then the supply of fresh water for the inland need not be limited by shortage of fuel. The main difficulties will centre around the high capital cost which such installations will involve.

Transport

Atomic cars and trucks do not at present look attractive, but electric railways using power generated in atomic stations located at intervals along the track may be economic in areas away from coal supplies. The possibility of a nuclear powered locomotive cannot be ruled out and nuclear powered aircraft may in due course be possible. If they would ever be economic for commercial purposes is at present unknown.

Educational Aspects

Atomic development is moving forward so rapidly at present that we must make sure our educational programmes will supply trained people required so that new knowledge can be used as it develops. We must make certain that all persons being trained for research work have some knowledge of the use of isotopes. The newly formed Australian Institute of Nuclear Science and Engineering has a part to play here.

THE UNIVERSITY OF SYDNEY

LECTURESHIP IN ANIMAL HUSBANDRY

Applications are invited for the position of Lecturer in Animal Husbandry. Applicants should be graduates with post-graduate training in animal nutrition. Experience is particularly desirable in the production of meat animals off grass, carcase composition and quality studies. The successful applicant will be stationed at the University Animal Husbandry Farms at Camden. The salary for a Lecturer is within the range £1,500-90-£2,100 per annum, plus cost of living adjustment (at present £13 p.a.) and will be subject to deductions under the State Superannuation Act. The commencing salary will be fixed according to the qualifications and experience of the successful applicant. Under the Staff Members' Housing Scheme in cases approved by the University and its Bankers, married men may be assisted by loans to purchase a house. Applications, giving the names of three referees, should be forwarded to reach the undersigned, from whom further information may be obtained, not later than 20th April, 1959.

M. A. Telfer,
Registrar.

Sydney,
February, 1959.

CHEMISTRY AND THE FUTURE OF AGRICULTURE

J. MELVILLE

Over the past century the science of chemistry has brought about marked changes in agricultural practices, changes which in the past two decades can be described only as a minor revolution. Its impact, which increases with each year that passes, has two dramatically opposed results: on the one hand the chemist is the Dr. Jekyll who has done so much to improve the efficiency of nearly every aspect of farming; on the other he is the Mr. Hyde who has produced and is producing substitutes for products which traditionally have been agricultural monopolies.

The Chemist as Dr. Jekyll

In presenting the chemist as Dr. Jekyll I cannot do better than use as my first example the science of plant nutrition. In no agricultural problem has there been a longer history of participation by the chemist; in no agricultural field has Australia made a greater contribution.

The early chemists argued from the obvious premises that whatever elements they found by analysis of plant tissue were essential to that plant's welfare; that only relatively few mineral elements constituted the vast bulk of the plant ash, and that the poor growth of plants in an otherwise suitable environment could be rectified by the addition of one or more of these major constituents. These basic premises still hold, but they have been considerably modified in three directions. Instead of half a dozen essential elements we now know that at least 14 are required for normal growth and reproduction; we know that not only are these 14 elements essential, but that a balance must be maintained among them if optimum growth is to be realised; and we know something of the complexity of the soils in which plants grow, of their varying abilities to supply these essential elements, and of their varying capacities to render one or more unavailable when they are applied artificially.

My second example comes from the control which we have recently achieved over plant growth through compounds which are not nutritionally significant. Over the ages observant people have been interested in the patterns of plant development and in the reasons why, for instance, two very similar seeds such as those of subterranean clover and radish always give rise to such entirely different plants. Obviously there must be factors within these two species which regulate growth in one pattern for sub. clover and in a quite different pattern for radish.

In 1936 Kögl isolated compounds which showed specific activity in controlling plant growth, and which he called auxins. Since then organic chemists have synthesised the material which had been isolated and provided the biologist with substances which modify the pattern of growth and development in some desired direction. One application is the use of auxins to promote the rooting of cuttings which were difficult if not impossible to strike by conventional methods. Control of the development of buds, the production of seedless fruits, the prevention of pre-harvest drop of apples, control of harvesting time of pineapples, the prevention of sprouting of potatoes —all these and a number of others were made possible when Kögl put the problem on a chemical basis. But I don't think that anybody in 1935 could have predicted that, within

Dr. J. Melville is Director of the Waite Agricultural Research Institute, Adelaide.

20 years, a group of entirely synthetic materials, of which the prototype is 2-4,D, would take a place among the world's most important agricultural chemicals.

The discovery by Müller in 1939 that DDT would kill potato beetles opened a new chapter in the control of insect pests. Again the pattern which I outlined for the auxins was repeated. DDT which had been synthesised nearly 70 years before its insecticidal properties were discovered was the key for which the organic and industrial chemists had been waiting. The last 20 years have seen the synthesis of dozens of new insecticides which at least had their starting point in DDT, and of which the best known are lindane, aldrin and dieldrin.

Similarly the plant pathologist, who only 25 years ago had to rely very largely on Bordeaux mixture and lime-sulphur for the control of plant diseases, now has an almost bewildering array of therapeutant materials.

The Chemist as Mr. Hyde

In the second section of this talk the chemist is presented as the Mr. Hyde of agriculture, i.e. as the person who has been responsible for breaking a number of agricultural monopolies, and who is in the process of breaking many more. Through no fault of their own considerable numbers of farmers have lost all or part of their traditional livelihood from the results of chemical research.

To indicate how widely spread is the competition from chemical industry I quote from a recent report to the U.S. Congress. "Until about 1930 the only fibres used were from natural sources such as cotton, wool, flax, hemp and silk. Soap was made from agricultural oils and fats. Adhesives came from starch, glue and plant gums. Shoes and travelling bags were made almost wholly from leather. Paints were made from vegetable oils, alcohol from molasses and corn.

"But this condition was not to last. The chemical and petroleum industries foresaw the possibilities of research for developing new products made from coal and petroleum. Agriculture began to lose some of its markets. Synthetic fibres, plastics and detergents from new bases began to take over. From a position of almost total predominance the natural fibres lost 45 per cent. of their former markets. Synthetic detergents now represent two-thirds of the total household soaps. Ten years ago 80 per cent. of inedible tallow and grease was used in making soap. Now the figure is 30 per cent. Five years ago requirements for cattle hide leathers could not be met by domestic production. Importations were necessary. But in 1955 cattle hides were surplus in the United States. Sixty two per cent. of all shoe soles worn in the United States today have materials other than leather in them.

"In the past 25 years agriculture often has been researched right out of its own natural domains. Industry will continue to explore the unknown in search of new products and new uses for old products. Nothing is plainer in the economic pattern of today than that agriculture must compete in the areas of basic and applied scientific research. Agriculture should be enabled to compete as an equal in the contest for consumer acceptance. It is now losing by default."

The agriculture of the future, in Australia as elsewhere, will be determined in large degree by its ability to withstand competition from the chemical industry using non-agricultural raw materials, and nowhere is this more apparent than in the field of fibres. This competition started in the 1870's and 1880's when English and French investigators discovered quite empirically that cellulose could be dissolved by a number of reagents and brought out of solution in the form of a filament. Gradually methods became available for determining the molecular architecture, not only of artificial but also of natural fibres, and hence for gaining some understanding of why certain materials can be spun and woven, when so very many more cannot. This knowledge is summarised in Astbury's words: "Biological fibres are of the nature of molecular yarns spun from long chain molecules."

With that realisation came the first attempts to synthesise long chain molecules, to orient them so that they lie parallel to the fibre axis, and to bond them together by the intramole-

cular forces built into their structure. The attempts were successful and in 1937 the first truly synthetic fibre, nylon, was introduced to the world's markets. Since that date, and despite the hiatus imposed by World War II, a number of synthetic fibres have gone into commercial production, with results which are well known to every agriculturalist in Australia.

The growth of chemical competition to any agricultural product follows the general pattern described for synthetic fibres. The first stage is the analysis of the end-use to which the particular agricultural product is put, and the determination of the critical properties which make it suitable for that purpose. The second is the relation of these properties to the chemistry of the raw material in the hope of determining the types of molecules responsible for its usefulness. This is the critical stage, since the questions which must be asked may not be capable of an answer with our present knowledge.

The third stage is usually the search for cheaper natural products which by some chemical manipulation will provide a substitute for the traditional material. Thus vegetable oils which in their raw state are quite inedible can be produced much more cheaply than can butterfat. By relatively simple processes these vegetable oils can be hardened, flavoured, coloured and fortified so that they produce a substance almost indistinguishable from butter.

The final stage in the process is the attempt to produce synthetically, from quite simple starting materials such as benzene and acetylene, an entirely new product whose properties fulfil the original human requirement. The starting materials are derived largely from coal and petroleum which are the direct result of plant growth in past geological ages.

What of the Future?

Any consideration of future trends in the relationship between chemistry and agriculture must follow two main lines: the first is the part that chemistry can play in increasing the efficiency of production of those goods which agriculture now sells; the second is the assistance which chemistry can give in finding new uses for the products of the land, both old and new.

The pattern of chemical contribution to agricultural progress, as exemplified in the section on the chemist as Dr. Jekyll, is in process of considerable modification. For instance, having established that certain mineral elements are essential for normal growth of plants and animals, a process in which the chemist acts largely, if not entirely, as an analyst, the next stage is to seek an understanding of the mechanisms underlying essentiality; what function does copper perform in the liver of a sheep or in a leaf of subterranean clover, and why is molybdenum so important for the growth of brassicas? These questions, which can be answered only through the study of individual cells, fall within the domain of biochemistry, and the past 20 years have seen an increasing amount of effort devoted to their solution. The cost of such investigations into cellular activity increases each year and it is reasonable to ask what tangible results, in terms of increased farming efficiency, have accrued. The answer is "Precious little".

Yet despite this gloomy conclusion I am convinced that the emphasis being placed on biochemistry is amply justified, and that the past and present expenditures on biochemical research in agriculture will produce dividends in the not-too-distant future, far greater than any which have accrued from the chemical investigations of the past. This of course is no more than a statement of faith, but the pieces of the gigantic jigsaw puzzle of cell activity are slowly fitting into place; and we have reason for hoping that, as they do, we shall achieve a type of control over plant and animal growth which was undreamt of only 20 years ago.

The attainment of new methods of control over plant and animal growth processes, with the increased farming efficiency which will inevitably follow, will not on its own permit our agriculture the kind of future prosperity which it could enjoy. New uses must be found for the present products, and entirely new products must be discovered. This is the

chemists' responsibility and one which is closely allied to the description of the chemist as Mr. Hyde. The competition which agriculture is experiencing from chemical industry is based on simple compounds derived almost entirely from coal and petroleum. Coal and petroleum however are only the results of past photosynthetic activity, transformed by processes of which we know very little and conveniently concentrated in certain areas of the earth's crust. Why cannot we exploit the current growth of plants for the production of new materials for the benefit of mankind?

It is easy to point out some of the difficulties: seasonal production, low concentration over large areas, small production units and so on. But the basic reason is that the end products of plant and animal growth are materials of great chemical complexity; they consist of innumerable substances and molecular combinations which, once clearly understood, would open the way not only to quite novel uses, but to very much improved properties for present uses.

Unfortunately, the successes which have been achieved in utilising our agricultural harvests are still a long way from the real objective. To take only one simple illustration, blood is perhaps the most beautifully and delicately organised fluid in the world, yet we dry millions of gallons of it for use as fertilizer. We just do not possess the necessary knowledge to find some alternative and more profitable use.

In emphasising these gaps in our knowledge I am of course acting as devil's advocate, but, when attempting prophecy, it is essential to indicate where our deficiencies lie. My own view of the future is much less dismal. I believe that the chemist will find new agricultural products and new uses for old ones, and by so doing he will contribute his share to achieving the objects of the Institute, a prosperous and expanding agricultural industry.

THE PRODUCER'S VIEW OF THE NEXT TWENTY FIVE YEARS

W. A. GUNN

I am confident that Australia will continue to export her primary products provided we use discretion in encouraging the production of those primary commodities for which there are markets and we discourage those for which there are limited markets. My reasons for expressing confidence in our future ability to dispose of exportable surpluses is that in countries which enjoy a high standard of living there is an ever increasing growth in population. In many of these countries the ability to increase their agricultural production is limited. Therefore they will have to look outside their own boundaries for food and clothing. In addition there is an ever increasing population in those countries with a low standard of living which are already over-populated. These countries must be fed and clothed if we are to survive as a free world. People will not be contented unless they are fed and clothed, so it is a responsibility of the free world to find means by which peoples of these countries can be fed and clothed. I have no doubt that in the years ahead, ways will be found to help these people.

Australia has always looked to Europe to take our exportable surplus of primary products, but in recent years we have seen a growing demand in the East, particularly in Japan. I believe this demand will continue to grow.

Sheep and Wool

I am confident that we will continue to sell our growing exportable surplus of wool at satisfactory prices providing the industry takes advantage of the results of research in both textile and production fields. Substantial advances have been made in recent years and the funds made available for research will pay dividends in the future. Provided the research worker continues to deliver results such as he has in recent years, there will be no shortage of funds for expansion of the research work being undertaken in Australia.

During the last ten years Australia has increased the production of wool by two million bales. This rate of increase should continue for the next 25 years. If this prediction comes to pass, Australia will be producing ten million bales, or double the present production.

Wool production has increased for several reasons. Firstly high prices have provided finance to undertake new development. Good prices have provided the finance and the wool producer has taken advantage of them.

The disappearance of the rabbit has been another contributing factor to the increased production of wool. Most of us agree that the last 10 years have been extremely favourable, but I would suggest that several of them would not be looked upon as good years if we had had to carry the usual rabbit population.

Pasture development, particularly in the southern states, has also made a significant contribution towards increased production of wool.

It is interesting to note that production of wool in Queensland has not increased as much as it has in the southern states. Queensland did not have as many rabbits as the southern

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states and so we could not expect the reduction in the rabbit population to bring about the same advance in Queensland as it did in the southern states.

Queensland also has not seen the same development of improved pastures as have the southern states. This is because the same amount of research has not been done on the pasture problems peculiar to Queensland. Large areas of Queensland have a predominantly summer rainfall and the environment is much warmer. Therefore it has not been easy to apply to Queensland the results of research carried out in the southern states. For example, the results of research done in Victoria or New South Wales can be applied to a limited extent to Western Australia and South Australia, but the same results do not apply to Queensland. Nevertheless, considerable progress has been made recently in research work in Queensland and I am confident that it won't be long before we have the answers to our problems.

I do not believe that Governments in Queensland have given the same encouragement to land development as has been done in the southern states. Nearly the whole of Queensland is leasehold land and little encouragement has been given to those who have been prepared to spend large sums of money. We have seen money made by wool growers in Queensland invested in other states, particularly in South Australia, and Western Australia.

I have stated that I believe Australia can double the production of wool in the next 25 years. In making this forecast I assume that the Commonwealth Government's tax policy will continue to encourage land development. I am also assuming that wool prices will be at such levels as to enable the wool grower to continue to bring more land into production.

Substantial progress has been made in pasture improvement in the southern states but we must admit that we have only scratched the surface. There is no doubt that in the next 25 years many more acres will be made available for pasture improvement because of the discoveries that will be made by research workers.

Queensland has not developed as rapidly as the southern states but I have no doubt that in the years ahead Queensland will show considerable improvement. The research worker will, in the very near future, answer many of Queensland's pasture problems. The brigalow and belah areas will be developed at a more rapid rate. There are fifteen million acres of this land, of which only approximately five million acres are partially developed. This land will carry not less than one sheep to 2½ acres and could be improved to one sheep to the acre, or even better with the advanced scientific knowledge which no doubt will become available. There are other areas of Queensland where substantial development can, and will, take place. Of course not all areas will be used for wool growing. Some will be used for beef, grain and fat lamb production.

Meat Production

The future of mutton and lamb production is so closely tied to wool production that it is difficult to forecast what our increases are likely to be. Of course if wool production doubles in the next 25 years, mutton will also double. Lamb production will depend upon the economics of producing wool or fat lambs. In recent years, there isn't any doubt that wool has been the most profitable form of production, so provided comparisons in price do not alter we cannot expect lamb production to increase at the same rate as wool production. Nevertheless, our potential to increase production of lamb is tremendous.

We have unlimited potentialities to increase the production of beef. To say that we could double our beef production in the next 25 years would be an understatement. We have large undeveloped areas in Northern Australia which at the present time are not suitable for any other type of production.

There are those who say that Australia will not continue to have an exportable surplus of beef. I cannot subscribe to this theory. As the population of Australia increases, so will the production of meat in the southern states, but at a rate sufficient to take care of any increase in population. Therefore northern

Australia will continue to be substantially an export area.

In the last five years we have seen a substantial development in the beef cattle industry. Since the Fifteen Year Meat Agreement was signed, the beef producers of Queensland have invested over £30 million in property development. This, in itself, will increase production substantially. This money has been spent on fencing, watering facilities, timber treatment, yards etc. Provided finance continues to be available, this rate of development should continue.

Fortunately, we have large areas of Queensland where transport is not a problem, and rainfall is adequate. I refer to all the eastern coastal area of Queensland and to a lesser extent, the Gulf of Carpentaria. Little real development has taken place in these parts of Queensland, but with additional water, fencing, timber treatment, and pasture improvement, production could be multiplied many times. Unfortunately, at this moment, all the answers to our pasture problems are not available, but I feel our research workers will not be long in giving us the answers.

In the Darwin area of the Northern Territory rainfall is adequate and transport is not a major problem. With heavy expenditure on the development of land and markets, this area is capable of substantial improvement. Today, it is probably the most undeveloped area in Australia.

In addition to these areas, we have areas where rainfall is light and transport problems are great. If the transport problems are solved by Government action, better use will be made of these areas. The Barkly Tableland, for example, could be used as a breeding area for the fattening areas of Queensland. With efficient transport, south-western Queensland could be used to fatten substantial numbers of cattle. I would say, therefore, that there is no doubt that Australia could increase its volume of production of beef by four times.

Other Primary Products

I feel confident that in the next twelve months it will be proved that rice can be grown economically in the Northern Territory. I pay tribute to the courage of Mr. Robert McCulloch of Los Angeles in this regard. I have no doubt that when this project succeeds, it will be the greatest thing that has happened to the Northern Territory in this century. I am confident that they will produce the cheapest rice in the world in the Northern Territory.

There is no doubt that there is scope for the increased production of wheat provided markets can be found.

Sugar production could be increased, but wisely, the production of sugar is controlled to a volume for which we can find markets. We could increase substantially the production of tobacco in Queensland, but again we must find markets before we increase production.

Of course dairy production could be increased if there were no marketing problem. At the moment we are producing all the butter that we can sell and it would serve no useful purpose to increase production.

I am confident in forecasting that we have the potential to double our total production of primary commodities in the next 25 years. When the northern half of Australia is populated and developed to its full capacity, it has unlimited possibilities.

Producers and Scientists

Practically every primary industry has agreed to levy itself for the purposes of research. This is a healthy development and provided the primary producer is satisfied that the money is being spent wisely finance will become available for research in an increasing volume. It is healthy to hear wool growers asking "Is there enough money for research?" I would have expected that in the economic circumstances that the wool industry finds itself at the moment, there may have been a desire to restrict the money that is available for research. On the contrary the reverse appears to be the attitude of the wool industry. I have no doubt that this is the attitude that will be adopted by all primary industries.

Before I conclude, let me express a word of warning to Governments and primary producer organisations that are responsible for framing our future development pattern. We should discourage the production of those

commodities for which it is doubtful if markets are available. I refer particularly to wheat and dairy products. Future markets for these commodities are doubtful and we should encourage the production of those primary commodities for which markets are assured, particularly wool and to a lesser extent, meat. I believe we are going to continue to see markets for these commodities so we should encourage their production. Australia is not yet short of acres, so the emphasis should not necessarily be placed on production per acre, but on the production of those primary commodities for which we can find markets. Therefore I repeat that provided the prices ruling on world markets are satisfactory, we can, in the next 25 years, increase the production of our primary commodities to the full.

Book Review

FERTILIZERS FOR THE FARM AND GARDEN

By L. J. H. Teakle and R. A. Boyle

Angus and Robertson, Sydney, 1958

This is an important book for the Australian agricultural scientist, and an essential one for anyone concerned with fertilizers. It has for long been difficult to recommend a book on fertilizers to the Australian reader. An overseas book inevitably gives the wrong examples and refers to the wrong crops. Here at last we have a comprehensive book written for Australians, at a level which will satisfy the scientific reader. The authors comprise a Professor of Agriculture, with an earlier record as a state research officer, and a member of the fertilizer industry.

The authors have not always been sure of their reader's background and at places have gone to trouble to explain, for example, what "valence" and "catalyst" mean; but elsewhere a millimicron and a colloid are brought in without apology, and a scientific background is commonly assumed. This is wise, since without it one must exclude a great deal of valuable discussion. Articles from local and overseas technical journals are freely referred to, and the bibliography of ten pages contains over 80 per cent. of Australian references.

After three introductory chapters in which the relations of plant and soil are discussed, the authors deal with the central topic. There are chapters on types of fertilizers and their reactions in the soil, and then 80 pages on fertilizer experiments in Australia, from nitrogen (13 pages) to molybdenum. This is a most valuable compilation of material that has been scattered through many Australian journals. It is followed by chapters on fertilizer usage (with an abundance of statistics, including careful estimates of reserves and rates of exploitation) and recommendations. Only in this last chapter is the home gardener given a few pages; the book is concerned primarily with farming.

The authors have decided to use the scientific terms of the mid-twentieth century rather than those of the early nineteenth. Thus they use the word "chloride" rather than "muriate" for the common potassium fertilizer. (It was in 1810 that Davy showed that chlorine was an element and that so-called muriatic acid was simply the compound of this element with hydrogen.)

The book is well written and produced, with well-chosen photographs. It is free from printer's errors, and contains little which any informed reader would consider controversial.

G. W. LEEPER

THE FUTURE OF AUSTRALIAN FISHERIES

G. F. HUMPHREY

Scientists and administrators can help but the real key to the future expansion of Australian fisheries depends on the nation's housewives. A study of the industry from the housewives' angle would be of prime importance to all concerned with the planning of future development of the industry.

What are Australian Fisheries?

To answer this question is not easy. For instance the word Australian in this sense leads to many vague conclusions. Unlike the agriculturist who can draw boundaries on a map a research worker interested in fisheries has poorly defined borders to his sphere of interest. Inland fishing is of course an exception but this is not likely to be of commercial consequence for the foreseeable future. Salt water fishing immediately brings to mind the three mile limit. Unfortunately it means little. Bays and gulfs create ambiguities. The waters of Bass Strait are even more difficult to classify. The three mile limit harks back to the time when this distance was the maximum firing range of coastal guns and it has never been of practical value to those interested in fisheries.

Another approach to defining national boundaries is based on breeding grounds. For instance some populations of the so-called Australian salmon breed in Bass Strait and can therefore be classed as Australian. On the other hand the young fish move out from this area so even if it is recognized that this fish reproduces in Australian waters it certainly produces the bulk of its marketable flesh elsewhere. As a result, others can lay as much claim to it as Australia.

When we speak of *fisheries* definitions have become even more obscure, as much of the industry is not associated with catching fish in its true biological sense. To commercial fishermen the word refers to the catching and selling of animals that are obtained from the sea. This definition can be disputed by those interested in wild life. Whales for instance are not fish and the definition is even more ridiculous when one thinks of seals. However in Australia we are saved from this argument by having no sealing industry.

The Nature of the Industry

In considering the future of Australian fisheries, five major groups stand out as being important. They are the pearl oyster, the whale, the barracouta, the crayfish, and the tuna. Of these only the barracouta and the tuna are fishes. The pearl oyster is certainly not a fish, in fact it is not a true oyster but a mussel. Of the whales the humpback and more recently the sperm whale are the two most important species.

It is incorrect to state that Australian fisheries are concerned solely with these five groups. In fact at present the mullet and salmon are perhaps our most important. I am looking to the future and it would appear that the five groups I have mentioned offer the most promise either as being of international importance or at least of showing scope for future development.

At the present time our annual fisheries production is worth nearly £10 million. Of

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this, exports amount to about £5 million. Imports amounting to £5 million per annum come mainly from Great Britain and the Scandinavian countries and consist chiefly of fish for frying. These figures are of course very small in comparison to world trade. For instance our annual tuna catch has increased in recent years to about 1,500 tons but its insignificance is clear when we compare it to the annual world take of 2 million tons.

In recent years barracouta catches have declined from 9 million lb to 2 million lb. The reasons are not known, and because of lack of reliable statistics we do not know even if there are less fish in the sea or less fishermen trying to catch them. The same situation applies to crayfish. Declining numbers are suspected but there are such unreliable figures on weight of crayfish caught per man hour that it is impossible to make worthwhile deductions.

A short while ago the Commonwealth Government received £750,000 from the sale of a whaling station. This money has been put into a trust fund for research and development and is administered by the Department of Primary Industry. This should pave the way for an increase in work especially in relation to studying new fishing grounds.

The Great Australian Bight offers promise for development. Although the value of these waters has been recognized for a long time little commercial fishing has been carried out in the area mainly due to its isolation from large markets. Research on east coast fishing grounds began only after the industry had declined to a considerable degree, and it is planned that research on the fishery potential of the Great Australian Bight will be established early in the exploitation of these waters. The mistakes made with the east coast fisheries could well serve as a lesson for the establishment of fisheries in other areas. Otherwise problems may become insurmountable and a potentially valuable fishing ground discarded. In developing new ground the overriding problems are likely to be associated with marketing the catch.

Fisheries Research Organizations

Each State has a government department and the Commonwealth Department of Territories carries out regional work in the Northern Territory, Papua and New Guinea and Norfolk Island. These bodies do research, administer regulations, advise on equipment and control conditions of marketing and processing. The Department of Primary Industry is concerned with legislation and development at the national level.

In addition, C.S.I.R.O. maintains a Division of Fisheries and Oceanography. This group has three general functions; to undertake research, to disseminate the results of research and to train scientists. In comparison with other research organizations in Australia, training of research workers is an important function of the Division. This last function is inescapable as there are no undergraduate courses in fisheries. There are no such courses at Australian universities. There is none in Great Britain and only one in the U.S.A., but a number of Japanese and Russian universities offer undergraduate courses. The lack of specialized training adds to the difficulties in recruitment for the Australian laboratories.

An urgent need for increasing efficiency is in the field of designing gear to suit local conditions. For instance in catching tuna the Japanese use long line methods with fishing crews of up to 24 men on each boat. In Australia, where wages are higher and better living conditions are demanded, these methods are not suitable. Instead we need gear which can be operated by crews of three or four mn.

In developing new types of catching equipment the biology of the fish must be considered so that the numbers of any species are not depleted. Mistakes of this nature may have resulted in the decrease in catches of flathead from the New South Wales coast.

Compared to the agriculturist a fisheries biologist suffers from not being able to see the animals with which he works. He is forced to rely on sampling methods. His difficulties are intensified by his inability to examine even the whole of the commercial catch (whales are an exception). Not only biologists but chemists and physicists are required for a complete study of a particular species in any locality.

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Inland Fisheries

Inland fisheries will not be of any commercial consequence until the population of our country areas increases. At present fish are not required except for an occasional change in the menu and this situation is likely to continue. On the other hand it is a simple matter to stock farm dams and maintain a worthwhile stock of fish with relatively simple management techniques. Unfortunately most fresh water fish are inferior to salt water kinds for table use. The main value of inland fisheries is recreational in nature and for this reason alone they should be maintained.

What of the Future?

Until our human population rises considerably there does not appear to be much scope for marked development in Australian fisheries. I believe that our population will increase to as high even as 50 million. If this occurs there will be a very active and efficient fishing industry. The important thing is our attitude to eating fish. At the present time it is classed as an inferior food and even though this is not true the industry will not expand until population pressure forces a change in attitudes. However it is essential that an active research programme be started now so that when results are needed they will be at hand.

Book Review

SHEEP SHEARING EXPERTING

By L. D. Ryan

Angus and Robertson, Sydney, 1957

Mr. L. D. Ryan is the Teacher of Sheep and Wool and Sheep Shearing Experting at East Sydney Technical College.

His book contains ten chapters, commencing with a brief, interesting history of the development of sheep shearing machinery in Australia. Chapters II to VIII cover the Over Head Gear, the Down Tube, the Shearing Hand Piece, Grinders and Grinding, Belts and Belt Drives, Lubrication and the types of Power Units used to drive shearing machinery. Chapter IX is devoted to the relatively new device, the Shearing Table, and the last chapter to the preparation of gear for shearing and its general maintenance.

The book can only be described as a very good one of its type for the following reasons.

There has been no digression from the main purpose of explaining lucidly and thoroughly the mechanical actions of all parts of the shearing machinery, their correct installations, settings, and maintenance for efficient usage. Standard methods of fault detection are included where applicable.

A feature of the book is its detailed coverage of the different proprietary makes of shearing machinery available. By featuring differences in installation, working parts and maintenance requirements of the different makes of machinery the book becomes a general reference for all concerned with sheep shearing experting.

Excellently presented drawings are utilized sufficiently to clarify all descriptive material.

Mr. Ryan has not attempted a technical discussion of the engineering efficiency of modern sheep shearing machinery, but confined his remarks to obtaining maximum efficiency from the machinery as presented from the manufacturer to the farmer. His descriptive sections, tests and rules to apply in this regard are simple and practical in nature.

The book is thus deliberately limited to the practical application of Sheep Shearing Experting, and is valuable for the agricultural student, learner shearer, shearer, shed expert and farmer.

A minor fault in the book may be a tendency at times to state the obvious.

D. J. CANNON

IS AN EFFICIENT AGRICULTURE ALL THAT IS NECESSARY FOR AN EFFECTIVE TRADE POLICY?

J. G. CRAWFORD

The topic of this talk is by design a rhetorical question as the answer is simply "no". Much more than efficient agriculture is required for an effective trade policy. Yet without it we do not have a chance.

What is an Effective Trade Policy?

Briefly, an effective trade policy is one which enables domestic, economic and social objectives to be achieved. If Australia were a self-sufficient nation there would be no need for a trade policy. However this is not the case for, as we are striving to achieve full employment, a rapid growth of population and the development of our resources, we are forced to seek access to overseas goods, services and capital. We must therefore maintain an "open" economy.

Provided we remember that conclusions drawn from economic models are no better than the premises on which they are based it is useful to project our problems into the future. In making a projection of this nature Mr. E. A. Saxon (1958)* concludes that by 1976 our exports will need to rise by 62-77 per cent. (according to the population assumed) above the average for the 1952/53 to 1955/56 period when exports were about £800 million per year. In other words exports will need to amount to about £1,300 million to £1,400 million by 1976 to finance unrestricted imports.

An effective trade policy is one that enables us to acquire all the imports we need. At the same time it must persuade home and overseas investors to contribute to expanding enterprises and also induce overseas people to purchase our exports in sufficient volume to finance imports, freight, interest, dividends, etc. Mr. Saxon's model illustrates in a rather frightening way what this can fully mean. Yet, short of an oil discovery and the complete failure of substitutes for wool he perhaps has not been frightening enough.

Agricultural Efficiency Not Enough

Is an efficient agriculture all that is necessary? Clearly it is not. Our exports are other people's imports. To be sure we need an efficient agriculture but we must still persuade people to buy the output of that agriculture. Moreover it would not be fair to agriculture, to mineral production or to manufacturing, to assume that agriculture alone must do the job. It is most likely that there will be a rise in the proportion of manufacturing and mineral exports in relation to agricultural products.

Barriers to Selling Agricultural Products

One needs only to be a realist and not necessarily a pessimist to foresee difficulties standing in the way of a rapid increase in exports of primary products. Let us assume that our agriculture is efficient by world markets standards and on this basis examine the world trends which affect our ability to earn our way. Sometime it is assumed that so-called unfair trading is the only problem to overcome. The existence of agricultural subsidies in Europe and high price supports and surplus disposals in the United States are quoted as examples.

*Saxon, E. A. (1958)—The role of rural industries in providing for future Australian requirements. *Qtly. Rev. Agric. Econ.* **11**: 66.

Sir John Crawford is Secretary, Commonwealth Department of Trade.

Unfortunately there are more barriers to developing agricultural exports than these. I will now list some of the more important.

Terms of Trade

A high level of economic activity around the world is of great importance to Australian exporters. Under these conditions the demand for our products will normally be strongest. Economic recession combined with unfair trading make for weak demand and a depressed terms of trade*. In his predictions Mr. Saxon has assumed the terms of trade to be 17 per cent. better than pre-war. At present they are running about 10 per cent. below pre-war. Unless this state of affairs improves we will need more than a 100 per cent. increase in exports to pay for his estimate of imports in 1976.

Unfortunately there is a strongly rising trend in prices of manufactured goods and an erratic but falling trend in the prices of primary products. This is due on one hand to the strong desire for countries to develop and hence to acquire manufactured goods. On the other hand there is a prevailing tendency for countries to subsidize their agriculture at the expense of imports. A moderation of agricultural protectionism is urgently needed.

Agricultural Protectionism

In all its forms agricultural protectionism is a legitimate object of attack by Australia. It is manifest in our wheat marketing problems in Europe and our efforts to preserve markets against surplus disposals by the U.S.A. and French flour subsidies. It would of course be stupid to assume from the existence of these subsidies that there is no agricultural efficiency in Europe and America. Even if the high subsidies were withdrawn a great agricultural industry would remain. However as a report to G.A.T.T. indicates even an almost marginal reduction where production is highly protected would mean a considerable fillip for exports from low cost producers.

*"Terms of trade" is the relation of import prices (I) to export prices (E). The higher $\frac{E}{I}$ the more imports we can buy for a given volume of exports.

Development of Substitutes

This is of considerable importance to Australia especially in relation to wool. We delude ourselves if we think there is no substitute for wool. There is for some uses, but we need not despair. High levels of economic activity are no less important than cheapness, reliability in supply and relative steadiness in price. Not least or last is the need to widen the appeal and uses of wool. If the promises of current research programmes designed to widen the attractiveness of wool are fulfilled they will yield a rich dividend for Australia.

Increasing Population in Asia

A factor of great importance for Australia is the rapidly growing population in Asia. For instance India's population is increasing by about 5 million each year. She needs annually an additional 500,000 tons of grain and is unlikely to keep up with this increased demand from her own production. India has balance of payment difficulties which appear likely to last for some time. To meet the difficulty the western nations will have to be bolder and more imaginative in their world economic policies. The so-called under-developed countries need trade *and* aid. It is in our interests for these countries to establish stable marketing conditions.

New Areas

Blocked by protectionism in Europe and North America, Australia must look to new areas. In this regard the economic future of Asiatic countries become of great importance. Recent trade treaties, the continuation of the Colombo Plan and Trade missions are significant of our interest in this challenge.

What We Might Do

Finding export markets is not a simple function of trade publicity nor is it simply a matter of having the world's most efficient farming enterprise, as we have for some products. Rather, our problems lie in the need to contain agricultural protectionism and to devise policies which will enable underdeveloped countries to expand their industries and trade. If we fail to achieve all we think we need, what alternatives short of unemployment and

falling living standards do we have? Answers are often suggested such as the fostering of "import savers". The development of a tinplate industry and an increase in tobacco production are two illustrations. To offset this opinion the facts indicate that the aggregate net demand for imports continues to rise so long as the national income grows and new investment takes place. The increased demand outstrips the import savings. This is the history of any country with a high rate of development and growth in population. It is some comfort perhaps to know that genuine "import savers" have made the situation less difficult than it might have been.

Increased borrowing has been suggested as a solution. The fact is that we are enjoying a very high level of overseas investment now and dividend payments must be met. If these and capital repatriation exceed capital inflow in any year the help from borrowing may be illusory.

We could lower the immigration rate in order to reduce the strain on our economy. On the other hand immigration has been a major factor in our development. The net position is far from clear. All told I would much sooner face the difficulties of paying for active expansion than seek the doubtful advantages of a relatively stagnant economy.

We can increase the exports of manufactured goods and minerals. However these can only be expected to go a little way in reducing the task ahead for agriculture.

If we found oil in sufficient quantities to replace imports and freight charges the need for increase in rural exports would be reduced, perhaps even halved. However we have yet to find the oil and develop it. If we do a man-sized job is still ahead; for even half of Saxon's projected need of exports is a tall order.

In all agricultural export campaigns we must have the goods to sell and at the standard of quality we claim. We must maintain supplies. For instance, it is ridiculous to be short of wheat in any year. If our research and extension activities are inadequate we must face the need for more. Likewise if our credit systems are lacking we must devise new ones. If marginal areas need reconstructing we must not shirk this responsibility either. These things are all important because in the final analysis, efficient production is not obtained by luck or magic.

The need calls for a joint enterprise of government, producers, administrators and scientists. It ranges from the farm to the inescapable problems of world economic relations. The final truth is that as we help solve world economic problems we are making it more probable that an efficient agriculture will contribute most effectively to our great programme of developing Australia.

Responses to Molybdenum Three Years after Previous Application on Red Basaltic Soils on the Far North Coast of N.S.W.

F. G. SWAIN

A significant response to a second application of molybdenum, three years after the initial application, in a stand of subterranean clover on the red basaltic soils of the Richmond River district is described. It is suggested that legume pastures in this area be topdressed at least every three years with molybdenum in conjunction with the annual topdressings of superphosphate.

Molybdenum deficiency in the soils of the far north coast of N.S.W. is well established (Arthur 1950; Anderson and Arnot 1953; Crofts, Pulsford and Jenkins 1955) but no studies of residual effects have been made.

Anderson (1956), when reviewing the general position regarding frequency of application, stated that the bulk of evidence indicated that a single dressing of two ounces remained effective for many years (Anderson 1946, 1952; Newman 1955). In one particular instance Anderson showed that one dressing of molybdenum remained fully effective for ten years. He further suggested that on some soils and perhaps some crops, heavier dressings may be needed more frequently.

On the basis of the above information it was recommended that on the far north coast molybdenum be applied every five to eight years.

This paper describes field plot investigations and analytical work designed to determine the response to a further dressing of molybdenum three years after the initial application. The trial was conducted during 1957 on Mr. J. Corcoran's property, Wollongbar. The soil type was described by Nicolls, Colwell and Tucker (1953) as the Wollongbar series of the red basaltic soils and is believed to be representative of the 200,000 acres of Krasnozems within the Richmond River district.

Methods and Materials

A paddock was sod-sown in 1954 with 12 lb Clare strain subterranean clover, together with 2 cwt molybdenised superphosphate, 2 cwt dolomite and 28 lb slaked lime per acre.

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Figure 1—Responses to Molybdenum. Both plots had received superphosphate in March. The left side plot received a further topdressing of molybdenum superphosphate in July while the right side plot remained untreated.

Each year up to and including 1957 the paddock was top-dressed with 2 cwt ordinary superphosphate and 1 cwt muriate of potash. A factor which must be considered is the possible absence of molybdenum from the commercial molybdenised superphosphate used at sowing. No analysis of the fertilizer was carried out although the manufacturers claim a molybdenum content of 30 oz sodium molybdate per ton.

In 1956 the clover was severely damaged by a weevil, *Amnemus quadrituberculatus,* Braithwaite, Jane and Swain (1958). In an attempt to combat this weevil the paddock was top-dressed with 2 lb active ingredient dieldrin mixed with 65 lb superphosphate per acre in January, 1957.

During 1956 there was slight evidence of a molybdenum deficiency in the clover and during 1957 severe deficiency symptoms were evident. These were similar to those described by Rossiter (1951) and Anderson (1956). The stunted plants were nodulated but the leaves were smaller than normal and pale green or yellow. The stems and petioles generally showed a reddish brown colouration.

The following treatments were applied in randomised blocks with eight replications on July 8, 1957:

A. Nil Fertilizer.
B. Superphosphate, 2 cwt per acre.
C. Molybdenised superphosphate, 2 cwt per acre.
D. A.C.F. Pasture No. 1 Mix, 4 cwt per acre.
E. Sodium molybdate (A.R. Grade), 2 oz. per acre.

Treatment D was a mixture of 2 cwt molybdenised superphosphate, 2 cwt dolomite and 10 lb sodium nitrate. This is the recommended planting mixture for legume establishment on these soils. The molybdenised superphosphate used contained 12 oz molybdenum metal per ton. The fertilizers were mixed with moist sawdust and hand broadcast, the sodium molybdate being mixed with acid washed sand prior to mixing with the sawdust.

Two quadrats, 2′ 11″ x 2′ 11″, were cut per plot, each quadrat position being determined by the method of ranked sets, McIntyre (1952). The samples were botanically separated for clover which was at the flowering stage and dry matter yields were calculated.

Molybdenum analyses of the top growth of the clover were carried out on samples from Treatments A, C and E by the Chemists Branch of N.S.W. Department of Agriculture. The analysis method of Purvis and Peterson (1956) was used.

Results

A summary of the yield data obtained is presented in Table 1. Cuts were made on October 14, 1957.

TABLE 1

The effect of fertilizers with and without molybdenum on yield of subterranean clover.

Treatment	Sub. clover yield. Cwt. D.M. per acre
A. Nil Fertilizer	3.34
B. Superphosphate	2.51
C. Mo. Super	6.39
D. Pasture No. 1	6.57
E. Sodium Molybdate	8.50
Min. Sig. Dif. P = 0.05	3.80

The sodium molybdate treatment yielded higher than the other two treatments containing molybdenum (C and D) but not significantly so. However, the sodium molybdate treatment was significantly different from both the control and ordinary superphosphate treatments. It is felt that the difference between E and C or D is largely due to better solubility of sodium molybdate or to a greater amount being applied.

The results of foliage analyses for molybdenum are given in Table 2. There was a definite increase in the molybdenum content of the herbage with application of molybdenum.

TABLE 2

The effect of treatment on the molybdenum content of the clover.

Treatment	Mean molybdenum content of clover in p.p.m.
A. Control	0.2*
B. Mo. Super	0.31
C. Sodium Molybdate	0.31

*Based on only two precise determinations, 0.12 and 0.20 p.p.m.

Discussion

Similar symptoms to the ones described in this paper have been seen on other third and fourth year stands of clover in various parts of the Richmond River district. These areas were sown with Pasture No. 1 fertilizer which contains 3 oz sodium molybdate per 4 cwt.

The results obtained are new for pastures in the Australian environment and several possible reasons can be advanced to explain the response to subsequent molybdenum dressings. Fixation of molybdenum could have occurred due to the acid nature of the soil (surface pH 5.7), Nicolls, Colwell and Tucker (1953) or because of the large amounts of iron compounds present, Nicolls and Tucker (1956). Anderson and Oertel (1946) found a high proportion of molybdenum unavailable to plants in a soil containing large amounts of ironstone gravel.

Increased phosphate levels in the plots may have caused an increase in the utilization and an acceleration in the uptake of molybdenum by the clover. Anderson (1946) found that where molybdenum and phosphate were applied together, the response to molybdenum increased as the level of phosphate approached the optimum. His results also indicated that the uptake of molybdenum was increased by the response in growth to phosphate. Stout *et al.* (1951) showed that if the phosphate level of the soil is increased with the molybdenum level, molybdenum absorption is considerably increased, sometimes as much as ten fold.

Losses could have occurred from leaching, as this area is subject to a high rainfall of approximately 60 inches per annum with very heavy falls being experienced at times.

Molybdenum may have been removed in the forage by stock. Since 1954 this pasture has been strip grazed very intensively, the forage being removed and droppings not returned. Research by Stout *et al.* (1951) supports this as they found that under conditions of intensive cropping and at high phosphate levels added molybdenum is very rapidly removed.

As a result of this preliminary study detailed research is now being carried out to determine the responses to various rates of molybdenum and to examine more closely the residual effect of molybdenum in this area.

Until further information becomes available it is suggested that legume pastures in the red basaltic soils of the Richmond River district be top-dressed at least every three years with molybdenum, in conjunction with the annual top-dressings of superphosphate.

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Technical Notes

Occurrence, Spread and Severity of Blue Mould, *Peronospora tabacina* Adam, of Tobacco in Field Plants

In the course of investigations on epidemiology of blue mould (*Peronospora tabacina* Adam) in the field, observations were made on two blocks of plants grown at Canberra, A.C.T. One block of 270 plants was grown in partial shade, and a similar block nearby was unshaded. A central group of 18 plants (see Figure 2) in the shaded block was inoculated with a water suspension of conidia. When sporulation occurred, the remaining plants under shade and those in the unshaded block became subject to natural infection. In the unshaded block, this natural infection was supplemented by spray inoculation with conidia. The plants were then about 90 cm in height and growing rapidly.

Occurrence

The first disease lesions appeared on the shaded plants, mostly on leaves 9-13 (counting from base of plant), at six days after sporulation on the 18 artificially inoculated plants. In the unshaded block, lesions first occurred on a similar leaf group in plants that had been fertilised with organic manures and had large, succulent, soft leaves (Figure I, III and IV). In other unshaded plants that had been grown either without added nitrogen or with high nitrogen supplied from inorganic sources, the leaves were of normal size and primary lesions were most common on leaves 5-8 (Figure 1, I and II).

The number of diseased lesions increased with time and at one week after the recording of primary lesions, all plants in both shaded and unshaded blocks showed fewest lesions per unit area on upper leaves. (Figure 4). This distribution persisted even when individual plants were spray inoculated and kept under

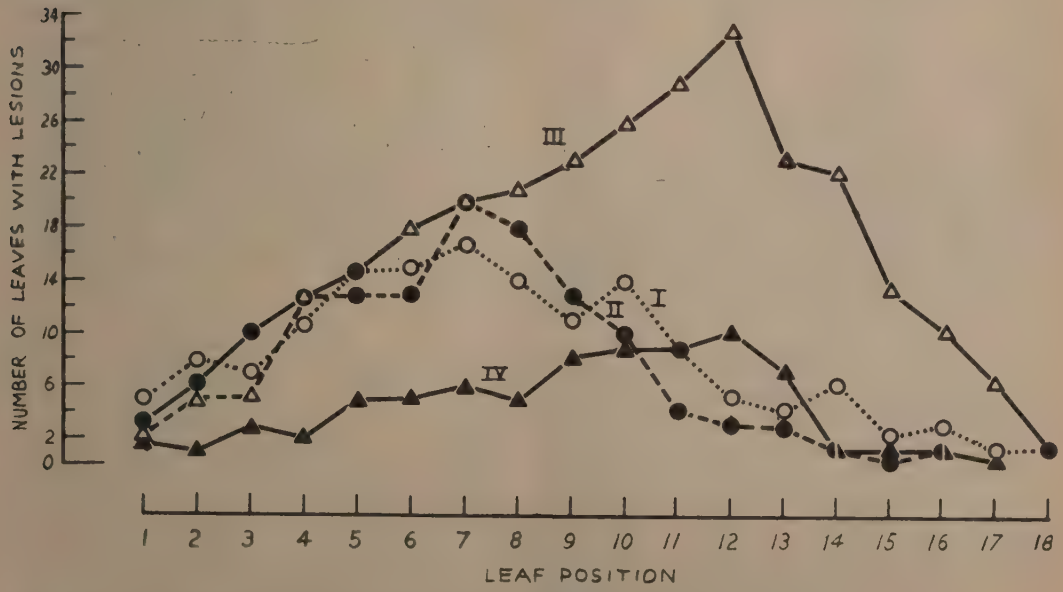

Figure 1—Leaf position and occurrence of primary lesions of blue mould—I inorganic nitrogen, II no fertiliser, and III organic matter treatments, all unshaded and inoculated artificially. Treatment IV was shaded and subjected only to natural inoculation.

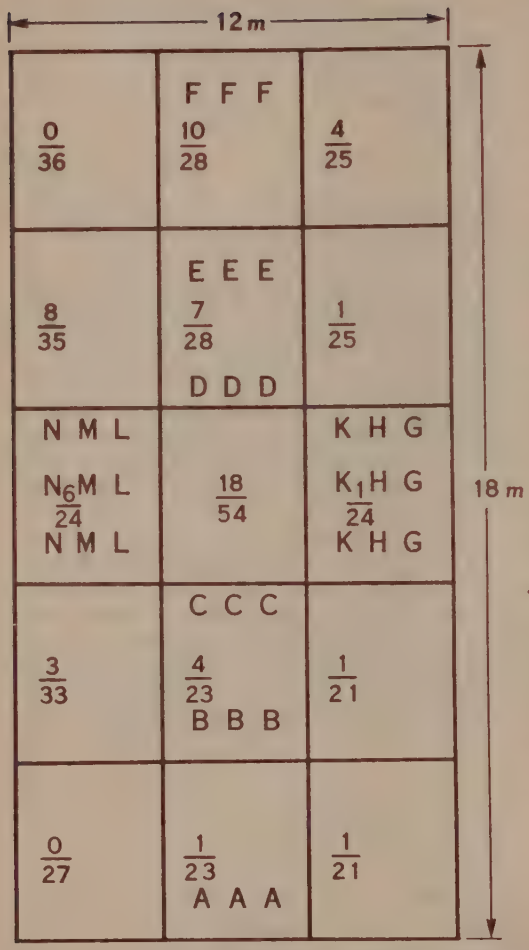

Figure 2—Plan of shaded tobacco showing number of plants with primary lesions of blue mould (numerator) and a disease rating for each plot of 18 plants at 17 days later (denominator). Natural spread from centre plot. Disease rating obtained by summation of ratings of 1 = light, 2 = moderate, 3 = severe for each plant. Position of plants used in study of occurrence and distribution of lesions is shown by letters A-N.

humid conditions. Thus the occurrence of fewer lesions on upper leaves was not due to distribution of conidia at different heights throughout the blocks. From this it appeared that the chances of the green upper leaves becoming infected were less than for the lower leaves.

A greater number of lesions occurred on plants with the primary lesions at the higher level, leaves 9-13, than on those with primary lesions on leaves 5-8. Distribution of plants with primary lesions and a disease rating at 17 days after primary lesions were recorded, is shown in Figure 2. The role of wind in spread of disease is clearly indicated. Results are in general agreement with those of Waggoner and Taylor (1955) who found that few lesions occurred beyond several yards from the source of infection and concluded that "sources of infection on his own farm are the primary danger to the grower's tobacco".

From results in the two blocks of plants it appeared that the chances of lesions developing on any particular group of leaves were modified by rate of growth of leaves, nitrogen nutrition and leaf maturity and that a rapid increase in lesion number could be expected under shade or in plants with large, soft leaves.

Spread of Disease

Observations on the number of lesions on 36 shaded plants were made at 11 and 21 days after they were first subject to infection. The 11-day results, shown graphically in figure 3, are typical for plants at 6, 3, 1 metres south (A-C) and north (F-D) of the source of infection while GHK (east) and NML (west) are for 4, 2.7 and 1.5 metres respectively. There were very few lesions at A, 6 metres upwind and less at C, one metre upwind than at D, one metre downwind. The disease spread to all plants in each block in approximately 21 days from the time of its first appearance in them. Typical distributions of lesions according to leaf position are shown in figure 4 for groups B and D, for plants inoculated artificially and for a plant severely damaged by the disease. All follow the same pattern.

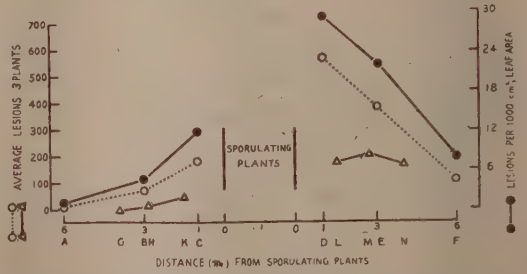

Figure 3—Number of blue mould lesions on plants subjected to natural infection for 11 days. Plants A-N (see figure 2) were at different distances in 4 directions from sporulating plants in central block.

Damage by Blue Mould

The number of blue mould lesions provided evidence of establishment of the pathogen but not of extent of damage to leaf tissue. In most plants the area of leaf destroyed was relatively small but commercial value of the leaf was much reduced. Early lesions on green, fully-grown lower leaves developed to about 2 cm diameter, the affected areas died and the sites were marked either by brown tissue or a hole. On ripening leaves there were small, chlorotic lesions but the leaves remained intact and were of value commercially.

Destructive spread of the pathogen occurred only in leaves of less than full size at time of sporulation. A typical example was a plant (Figures 4 and 5) with six leaves of full size, all of which had numerous small lesions, least being on the topmost and most on the lowest leaf. Leaves 7 and 8, which were not of full size when they became infected, did not have any more lesions than leaves 5 and 6 but the lesions were large and occupied much of the leaf area. On leaves 9, 10 and 11, there were fewer diseased areas but leaf veins were infected and leaves distorted. Leaves 12-15, with

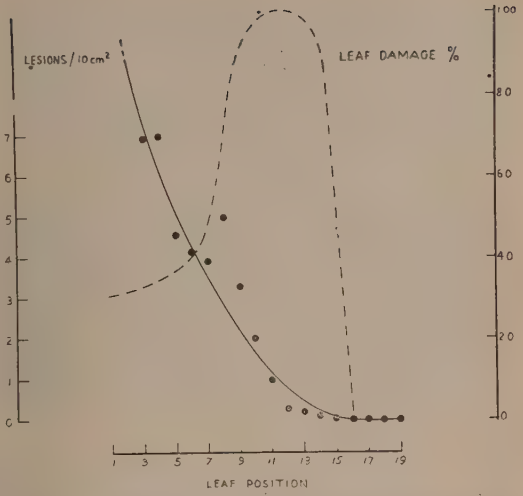

Figure 5—Number of lesions and estimated leaf damage for each leaf position—Plant I in figure 4.

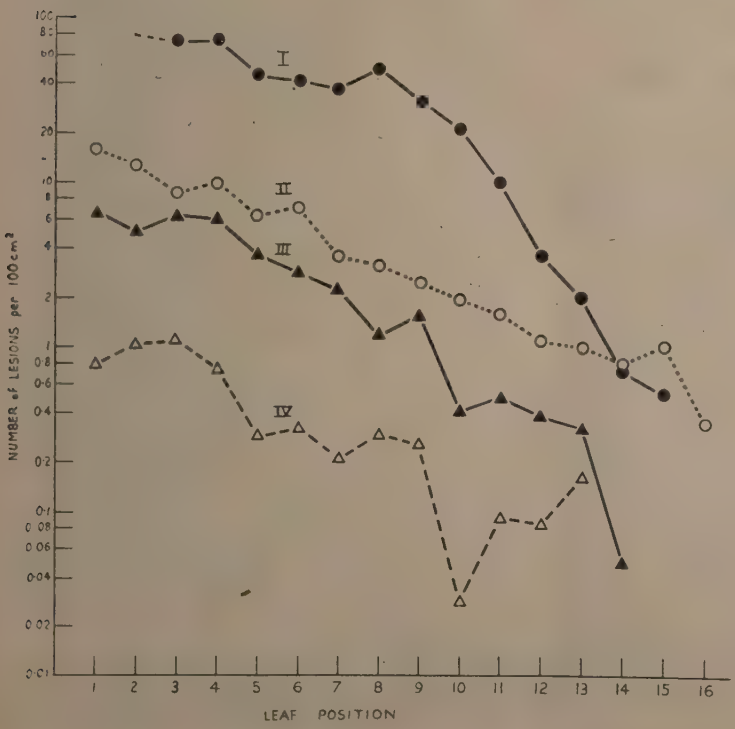

Figure 4—Distribution of blue mould lesions for each leaf position, omitting chlorotic bottom leaves and healthy top leaves.

Plants in flower.

I Single plant with leaves 9-15 destroyed.

II Average of 5 plants inoculated artificially.

III Average of 3 plants 1 metre downwind (D of figure 2).

IV Average of 3 plants 3 metre upwind (B of figure 2).

very few lesions, showed additional injury due to midrib infection, and the remaining four leaves apparently escaped infection when small. Severe injury on leaves 7-15 was associated with few lesions and extensive spread of the pathogen within the leaves (Figure 5) especially in the vascular system.

Severity of attack was of the same order in leaves of similar physiological age but economic loss varied with plant height at the time of attack and the duration of conditions favouring the disease. In practice, the attack may occur at any stage of growth, the leaves severely damaged being those growing rapidly at that time and they may be at any level on the plant. With seedlings and young transplants up to about 18 inches in height, rapid spread of the pathogen in leaves was followed by stem infection and severe stunting, especially in plants on relatively infertile soils.

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The Effect of Crushing on the Drying of Pasture Plants

The crushing of pasture plants at the time or shortly after they are harvested usually results in their drying more rapidly than uncrushed material dried under the same conditions. This fact has led to the development and marketing of a number of crushing machines known variously as hay crushers, forage crushers, grass crackers, hay conditioners and, when combining both mowing and crushing in the one machine, as mower crushers. In these machines the cut pasture material is fed between either smooth or corrugated rotating rolls which crush or crack the stems and other thick portions of the plant and bruise the leaves. The idea is not actually to squeeze moisture out of the plants although a small loss of moisture does usually result from the treatment; rather, the action is intended to increase the rate of drying of the stems so that they dry more nearly at the same rate as the leaves.

The actual value of crushing as a practical aid in haymaking is obviously influenced by such factors as type of crop, its maturity, and the weather. Varied results have been obtained under different field conditions both in overseas investigations (White and Kalbfleisch 1950; Bruhn 1955; Mitchell and Shepperson 1955), and in those conducted by C.S.I.R.O. (Tisdall and Shepherd, unpublished data). These results have led to conflicting opinions among the agricultural community in general regarding the advantages of crushing.

Field trials for evaluating such a process are fraught with difficulties such as crop and machinery variations, sampling errors and, above all, the vagaries of the weather. For this reason a laboratory approach to the problem has been made and it has been possible to eliminate most of these difficulties. Although the results obtained do not permit any hard and fast conclusions to be drawn about the use of commercial crushing rollers, they do provide some indication of the potential value of the process.

Experimental

Investigations were made with white clover (*Trifolium repens* L.) at two different stages

of maturity and with lucerne (*Medicago sativa* L.) (See Table 1). Test material was harvested with hand shears, leaving a short stubble —as would be expected had it been carefully cut with a mowing machine. About 500 grams of plant material were harvested at one time and well blended. This material was then randomly sampled to give 36 lots each of approximately 10 grams. These samples were loosely packed in weighing cans, one third direct and one third after first being given either a light or heavy crushing with an ordinary hand-operated clothes wringer. The light treatment had little more than a slight bruising effect and even with the heavy crushing there was no sign of stripping of leaves or clipping small stems of the lucerne as is sometimes noticed with commercial crushing rollers set at excessively high pressure. In the first clover test the material was fed sideways through the rollers but in the second clover test and in the lucerne test it was fed through lengthwise. This latter procedure would probably be closer to actual practice.

The weighing cans had flywire inserts near the bottom and lids for both top and bottom. By removing both lids air could be circulated through the can without fear of loss of the sample. Constant drying conditions (21°C and 65 per cent. relative humidity) were provided in a cabinet fitted with a fan to ensure a definite downward air-movement.

TABLE 1

Comparison of drying times of crushed and uncrushed samples from three different pasture swards.

Species Maturity Ratio $\frac{leaves}{stems}$ (dry weight)	White Clover Early flowering 1.19.		White Clover Full flowering 1.24.			Lucerne Early flowering 0.92.		
Initial moisture content (m.c.) (% dry wt)								
stem	860		879			463		
leaves	454		537			386		
whole	640		690			426		
	Uncrushed	Heavy Crush	Uncrushed	Light Crush	Heavy Crush	Uncrushed	Light Crush	Heavy Crush
Loss of moisture due to crushing (% dry weight—whole sample)	—	17	—	20	43	—	5	13
Hours to dry to 30% m.c. (% dry wt)								
stem	66	26	69	46	32	112	64	29
leaves	31	22	52	35	26	52	37	23
whole	49	24	60	40	29	101	50	26
Moisture content of stems and leaves when m.c. of whole is 30% (% dry weight)								
stems	48	37	47	41	39	43	42	34
leaves	15	24	17	21	23	16	17	25

Duplicate samples were removed from the drying cabinet, after periods of drying from 0 to 100 or more hours, divided into leaves and stems (petioles included as stems) which were then weighed separately in smaller weighing cans and oven-dried for moisture content determination.

Additional samples were taken on each occasion and used to determine the loss of weight during crushing, five replicates being weighed before and after treatment.

Results and Discussion

The results of the three tests are summarised in Table 1. The loss of moisture due to crushing was smaller with the first lot of clover which was fed sideways than in the second lot. It was also much less with lucerne than clover.

The drying time was substantially reduced by heavy crushing and quite appreciably even by light crushing. The reduction was more pronounced with the stems which are usually at a higher initial moisture content than the leaves.

The reduction in hours to dry to an average of 30 per cent. moisture content was:—

	Light	*Heavy*
1st Clover		25
2nd Clover	20	31
Lucerne	50	75

The difference between leaves and stems at 30 per cent. moisture content is important because at about this average value (23 per cent. test weight basis) the crop is considered safe for baling. With uncrushed material it is fairly obvious that by the time the average moisture content had reached 30 per cent. the leaves had dried out to the brittle stage and would have been likely to shatter during baling. The differential was much less, especially with heavily crushed material, so that the problem of leaf shatter could be expected to be less.

Experience has shown that the effect of crushing is more pronounced with succulent stemmed plants, such as clover, than with ryegrass. In the usual type of clover/ryegrass mixture the rate of drying of the grass is the limiting factor and crushing is unlikely to prevent the clover leaves drying to the brittle stage before the average moisture content of the mixture is low enough for baling.

Dry matter loss determinations using six replications were carried out with material and treatments similar to those described above. In no case did the results show any significant total dry matter losses due to crushing. There was some indication that the losses during the more rapid drying after crushing were less than during the drying of uncrushed material but the differences were not statistically significant.

Acknowledgement

The technical assistance of Mr. R. E. Spielrein who, until recently, was a member of the Fodder Conservation Section of C.S.I.R.O. is gratefully acknowledged.

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The Effect of Laceration on the Drying of Pasture Plants

Considerable interest has been shown in the possibility of using the flail-type forage harvester for haymaking. The idea is to have the forage harvester deliver the plant material on to the stubble in the form of a windrow from which it will, when dry, be picked up and baled. The forage harvester thus becomes a general utility machine which can be used for both silage and haymaking and also green feed harvesting. It is claimed that pasture harvested by flails and thereby lacerated dries more rapidly than when simply cut with a mower. Disadvantages are that, as with crushed material, the lacerated plants are more susceptible to damage by rain and also that there is a danger of some of the lacerated material being so small as to be lost. Whereas crushing shows to advantage with plants like clover and lucerne, laceration is more likely to be useful for grass. Clover harvested with flails is suspected of being particularly susceptible to leaf loss.

Field investigations of the effect of laceration on rate of drying are difficult to carry out for the same reasons as with crushing, and laboratory tests generally similar to those with crushing described earlier,* have been made with laceration.

Experimental

Investigations were made with pure ryegrass, a crop of cluster clover, and a ryegrass/clover mixed pasture (see Table 1). The ryegrass was harvested with a rotary type of lawn mower adjusted to simulate a flail type forage harvester; the other two crops were harvested with commercial forage harvesters. Control samples were cut with hand shears.

Twelve 10 gram samples of both treated and control material were prepared in the special weighing cans described previously* and placed to dry in a current of air at 21°C and 65 per cent. relative humidity. Duplicate samples were removed after periods of drying from 0 to 144 hours and oven dried for moisture determination.

Results and Discussion

The results of the three tests are summarised in Table 1. Laceration resulted in considerably faster drying particularly of the ryegrass. A noticeable result of the laceration in the first two tests was the quantity of fine material which appeared in the dry samples and which might well be lost in large scale handling operations such as baling. In the ryegrass/

*See "The effect of crushing on the drying of pasture plants", by W. L. Greenhill in this issue.

TABLE 1

Comparison of drying times of lacerated and untreated samples from three swards

Species	Ryegrass (short-rotation H1)		Cluster clover		Ryegrass/White clover 90%/10% (D.W. basis)	
Maturity	Early flowering		Pre bloom		Ryegrass in head clover pre-bloom	
Initial moisture (% dry wt)	430		530		462	
	Control	Lacerated	Control	Lacerated	Control	Lacerated
Hours to dry to 50% moisture (% dry wt)	52	18	16½	11½	27	16
Hours to dry to 40% moisture (% dry wt)	88	20	18½	13	41	19½
Hours to dry to 30% moisture (% dry wt)	120	30	21	15	90	30

clover mixed pasture there was little fine material; this may have been due to the condition of the crop which was relatively mature or to the design and speed of the flails.

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The Control of Water Couch, *Paspalum Distichum* L. in Irrigation Channels by 3-Amino, 1,2,4-Triazole (Amizole)

During the course of investigations into methods of controlling Cumbungi (*Typha angustifolia* L.) in drainage channels in the Murrumbidgee Irrigation Area of New South Wales, it was observed that heavy rates of 3-Amino 1,2,4-triazole (Amizole) also controlled water couch (*Paspalum distichum* L.) This stoloniferous species normally invades channels from which *Typha* has been removed and is probably the most serious weed of irrigation channels in New South Wales and Victoria.

To obtain confirmation of the above observation a small experiment was started in January 1958 in a drainage channel heavily infested with water couch. Amizole was applied by a knapsack sprayer as a water solution to which a wetting agent, 0.1 per cent. Multifilm L., had been added. One hundred gallons per acre of solution were applied to each plot at a pressure of 60 lb per square inch. Each plot was a section of channel nine feet long by eight feet wide and was replicated four times in a randomized block design.

The effect of treatments was determined from estimates of the percentage of ground covered by living water couch and from four 1 x 1 ft quadrats cut in each plot. The treatments used and the results obtained are shown in Table 1.

TABLE 1

Effect of 3-Amino, 1,2,4-triazole on Paspalum distichum L. Means of four replications.

Treatment	Three Months after Treatment	
	Estimated Ground Cover—%	Dry wt—Gms/sq ft
Control	100	90.7
Amizole 25 lb/ac	30	37.6
Amizole 50 lb/ac	0	0.0

The result of this small scale test indicated that Amizole at 50 lb per acre would effectively control water couch and since at this rate of application it also will eradicate Cumbungi (*Typha* sp.) (Levi 1958—in press) Amizole offers an effective means of keeping supply and drainage channels free of these two major weeds. Even at the comparatively heavy rates of application necessary, the reduction in the frequency of channel cleaning operations and the consequent saving of labour should make the method economically practicable.

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The Gross Protein Value of Australian Meat Meals

The broiler industry in Australia is inefficient when compared to that in the U.S.A. or Britain. The best commercial growers in Australian can only achieve a 4 lb bird at 12 weeks of age, with food conversion ratios of about 4. Overseas growers have obtained 3 lb birds at 8 weeks of age, with food conversion ratios of little more than 2. Part of the reason for this inferior performance undoubtedly lies in the absence of good strains of meat breeds, but better results could be obtained even with existing breeds if improved rations were introduced.

American broiler rations are based on maize-soya bean mixtures, and British rations depend upon cereal-fish meal combinations. In both places a great deal of experimental work has been done to show what additions are necessary to improve the efficiency of these basic ingredients. In Australia the basic ingredients of broiler rations are wheat and meat meals and little work has been done to show how these may be improved by supplementation with trace substances.

In America March, Biely and Young (1950) found that lysine was the first, and methionine the second, limiting amino acid in a wheat-oats-meat scraps diet, and Patrick (1953) reported a similar situation with a maize-meat scraps diet. McDonald (1958) has reported from New South Wales that the supplementation of a wheat, meat meal ration with methionine did produce an increased efficiency of food conversion and an increased rate of chick growth.

This note reports the results of an experiment in which the gross protein values (GPV) of four Australian meat meals were measured by the standard chick growth technique of Heiman, Carver, and Cook (1939).

Table 1 shows the results obtained and compares them with those determined by the same technique on animal protein foods and soya-bean meal in overseas laboratories. From this it will be seen that the Australian meals are markedly inferior in value to the fish, whale meat, and soya-bean products.

TABLE 1

The gross protein values of four Australian meat meals compared with values reported from overseas for a variety of animal protein foods and soya-bean meal.

Sample	Gross Protein Value
Overseas products	
Herring meal, steam dried	98
Herring meal, flame dried	93
White fish meal	96
Whale meat meal, flame dried	95
Soya-bean meal	76
Australian meat meals	
No. 1	67
No. 2	63
No. 3	67
No. 4	65

Carpenter and Ellinger (1955) have demonstrated the highly significant relationship that exists between the GPV of an animal protein meal and its "available lysine value". It may therefore be assumed that the low GPV of the Australian meat meals tested is due to their low available lysine content.

It can be concluded that, unless another amino acid were really critical and occurred in some fixed relation to the available lysine content, lysine is usually the critical amino acid which limits the value to chicks of Australian wheat-meat meal rations.

As has been pointed out by Underwood, Conochie, Reed, and Smyth (1950) Australian meat meals are really slaughter-house meat and bone meals which contain a large proportion of connective tissue, viscera, and bone, and they are probably deficient in several amino acids.

Unfortunately the knowledge that supplementation by lysine as well as by methionine would improve the protein value of meat meals is not likely to prove of immediate practical benefit to the broiler industry since, at the

moment, lysine is so expensive that its inclusion in commercial rations is unlikely to improve economic, as well as nutritional, efficiency.

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Black Ringspot Disease of Crucifers

Production of cruciferous vegetable crops in New South Wales has, as far as is known, not been significantly depressed by the incidence of virus diseases. Noble *et al.* (1934) recorded an undetermined mosaic disease of cauliflower (*Brassica oleracea* L. var. *botrytis* L.) in the Sydney Metropolitan Area.

In June 1957, a disease of broccoli (*B. oleracea* L. var. *botrytis* L.), cabbage (*B. oleracea* L. var. *capitata* L.) and cauliflower occurred in the trial grounds of a seed merchant at Dundas in the Sydney Metropolitan Area.

The symptoms exhibited by affected plants were as follows:—

Broccoli: Chlorotic ringspots were occasionally present on the younger leaves. On the outer leaves, yellow or brownish spots surrounded by necrotic margins of circular or irregular outline were present (Figure 1). Generally these lesions occurred in the vicinity of the leaf veins. When a number of the lesions coalesced, blighting of sections of the leaf resulted.

Figure 1—Necrotic ringspots on leaves of Waltham No. 29 broccoli.

Cauliflower: The lesions on the outer leaves were similar to those on the outer broccoli leaves.

Cabbage: The lesions on the outer leaves of cabbage were more uniformly necrotic than on the other two hosts but some showed a ringspot pattern.

Varietal Reaction

Three varieties of broccoli and one each of cabbage and cauliflower were being grown in the trial ground. With broccoli necrotic ringspotting was most intense on the outer leaves of Waltham No. 29 and lesions were also evident on the youngest leaves. A number of the outer leaves had abscissed and infection had exerted a depressing effect on the vigour of this

Figure 2—Defoliation of Waltham No. 29 (right) and Morse Medium (left) broccoli.

variety (Figure 2). The outer leaves of Morse Medium and Morse Early were much less severely affected and abcission had not occurred at the time the planting was inspected. Infection did not noticeably depress the vigour of Morse Medium and Morse Early. Practically 100 per cent. of the plants of the three broccoli varieties were infected.

The disease on Shorts cauliflower and Enkhuizen Glory cabbage was evident on only a few outer leaves. About one per cent. of the cabbage and cauliflower plants showed symptoms.

Figure 3—Local lesions on tobacco leaves.

Identity of the Disease

The disease appeared to be of virus nature and the symptoms bore strong resemblance to those described for Black Ring disease of cabbage and other crucifers in California (Tompkins, Gardner and Thomas 1938). The following identification tests were made:—

A. *Host Range*

Sap inoculations from the field specimens to tobacco (*Nicotiana tabacum* L.) var. White Burley and *N. glutinosa* L.; from these test plants to broccoli var. Greenspouting, cabbage var. Sugarloaf and swede (*B. campestris* L.) var. Purple Top and from these crucifers to tobacco and *Chenopodium album* L.

Figure 4—Reaction on N. Glutinosa.

Tobacco: Local lesions were produced on the inoculated leaves by each of the five isolates. These lesions were light tan in colour, surrounded by a reddish brown ring and a light halo (Figure 3).

N. glutinosa: Each isolate produced necrotic lesions on the inoculated leaves, with a systemic reaction in the form of chlorotic spots on both the inoculated and later formed leaves (Figure 4). Most of the leaves of the plants were eventually killed.

C. album: Lesions appeared first on the inoculated leaves in the form of yellowish spots with reddish margins. A systemic reaction of a similar type followed.

Cabbage and Broccoli: The first symptons occurred on the youngest leaves and took the

form of chlorotic ringspots usually centred on the veins. Eventually the leaves became finely mottled with a pattern of chlorotic and dark green rings or blotches on the normal green background. Some small necrotic ringspots eventually appeared on the lower leaves which usually abscissed.

Swede: An initial vein clearing was followed by the development of a coarse mottle with some development of dark green ring patterns.

B. *Properties of the Virus Isolates*

Three physical properties of the virus isolates, thermal inactivation, longevity in vitro and dilution tolerance, were determined. Expressed juice from broccoli, cabbage and swede test plants was given the appropriate treatment and leaves of tobacco and *N. glutinosa* plants were then inoculated with the treated juice. The results are set out in Table I.

Discussion

In the reactions produced on cruciferous and non-cruciferous test plants the virus isolates from crucifers at Dundas fall naturally into the turnip virus 1 group (Pound and Walker 1945, Walker, Le Beau and Pound 1945) = cabbage black ringspot virus (Smith 1957).

The physical properties of the virus isolates also accord with those of the turnip virus 1 group, particularly as regards longevity in vitro and thermal inactivation and bear no relation to those of the cauliflower mosaic virus (Smith 1957) = cauliflower virus 1 group (Pound and Walker 1945).

From the evidence presented, it is considered that the disease of broccoli, cabbage and cauliflower which occurred at Dundas, N.S.W., in June 1957 was caused by the cabbage black ringspot virus.

The source of the infection remains obscure. The virus is not seed borne (Smith 1957). The broccoli plants had been parasitized by the aphid *Brevicoryne brassicae* L., a vector of the virus, and this aphid had probably transmitted the virus to the plants from an undetermined source. It is possible that the virus has been present locally for some time and, if the effect produced on Enkhuizen Glory cabbage and Shorts cauliflower were an indication of the usual severity of the disease on these hosts, the disease could have previously passed unnoticed. This was apparently the case in South Africa (McClean and Cowin 1953).

TABLE 1

Physical properties of virus isolates from crucifers at Dundas.

Source of Virus	Inactivation Temperature °C—10 mins			Dilution Tolerance (x 10 in distilled water)			Longevity in Vitro 20°C—hours										
	55	60	65	1/10	1/100	1/1000	26	48	49	50	72	73	74	96	97	98	100	104
BROCCOLI	*																	
"Waltham No. 29"	+	+	—	+	+	—		+			+			—				
"Morse Medium"	+	—	—	+	+	—			+			+						—
"Morse Early"	+	—	—	+	—	—			+			—			—			
CAULIFLOWER																		
"Shorts"	+	—	—	+	+	—	+			+			+			—		
CABBAGE																		
"Enkhuizen Glory"	+	—	—	+	+	—	+			—			—				—	

* + = positive reaction on test plants.
— = negative reaction on test plants.
no symbol = not tested.

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The Microbial Decomposition of Sugar and its Effect on Phosphate Solubility

From the results of studies on the chemical effect of organic substances on phosphate solubility, Bradley and Sieling (1953) suggested that aluminium and ferric phosphate should become more soluble, and perhaps more available to plants, during the decomposition of organic matter in soil. The results of plant studies, however, do not entirely support this suggestion. For example, Paul and Delong (1949) found that a sugar treatment depressed soluble phosphate, and Williams, Bromfield and Wiliams (1958), in an examination of ferric, aluminium, and rock phosphate, found that only ferric phosphate became more available to plants.

Qualitative studies using microorganisms in liquid and agar media have shown that calcium, magnesium and ferric phosphates are dissolved during the decomposition of sugars (Gerretsen 1948; Johnston 1952; Rose 1957; Bromfield 1954).

Attempts were made in the work reported here to demonstrate quantitatively, during the microbial decomposition of a sugar peptone medium, an increase in the solubility of the three phosphates—especially the aluminium phosphate—used by Williams, Bromfield and Williams (1958).

Soluble inorganic phosphate and pH were determined at intervals on the supernatant of various mixed cultures grown in liquid media. The media consisted of an aqueous solution contatining sucrose, 5%; peptone, 2%; yeast extract, 0.001%; K_2SO_4, 0.01%; $MgSO_4$ $7H_2O$, 0.001% and NH_4NO_3, 0.25% and ground samples of phosphates (150 mesh) added separately at the following rates: rock phosphate 1.0% and 0.01%, aluminium and ferric phosphates 0.1%.

The cultures obtained by inoculating the medium (500 ml per litre conical flask) with 0.5 g soil were incubated at 27°C. Each treatment was in duplicate.

Results

The results presented in Figures 1 and 2 show that the solubility of all three phosphates increased in all cultures in spite of the variable course of decomposition in some duplicates. This poor agreement between duplicates demonstrates that the course of decomposition of a mixed microflora in a non-selective medium is to some extent unpredictable.

The maximum solubility of aluminium phosphate in cultures at pH 4.3 (0.58 mg PO_4/ml,

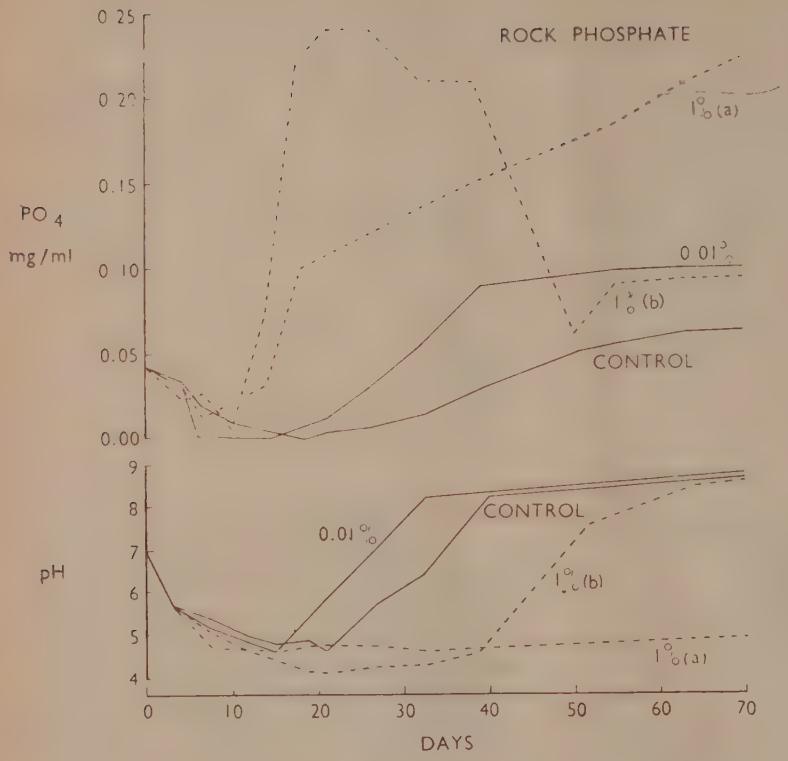

Figure 1—Trends of phosphate solubility and pH with time in cultures containing rock phosphate;
——— plot for mean of duplicate cultures.
- - - - plot for individual cultures.

Figure 2) is greatly in excess of that in buffer of the same pH (0.025 mg PO_4/ml (Bromfield unpublished data)). It is probable that complexing organic compounds (Struthers and Sieling 1950; Bradley and Sieling 1953) were responsible for this enhanced solubility. Such compounds probably also accounted for much of the difference between the initial and final solubilities of the phosphates (Figures 1 & 2).

The solubility of rock phosphate at the 1 per cent. level (Figure 1) appears to be closely related to the acidity of the cultures except at the very beginning, when soluble phosphate was decreased; due probably to the synthesis of organic phosphorus by microorganisms (Chang 1940; Kaila 1949). In cultures containing only 0.01 per cent. rock phosphate, soluble phosphate did not increase during the acid stage of decomposition, which suggests that the amount of phosphate dissolved in excess of microbial requirements depends in part on the amount of rock phosphate in the culture. The increase in solubility which occurred under alkaline conditions was probably from the autolysis of microbial tissue.

That ferric phosphate dissolved at pH values commonly found in soils, whereas aluminium and rock phosphate did not (Figures 1 & 2) is consistent with the results of the soil incubation studies of Williams, Bromfield and Williams (1958).

It is apparent from these observations that changes in the solubility of phosphate which occur in relatively simple microbiological systems do not necessarily occur in the complex environment of soils.

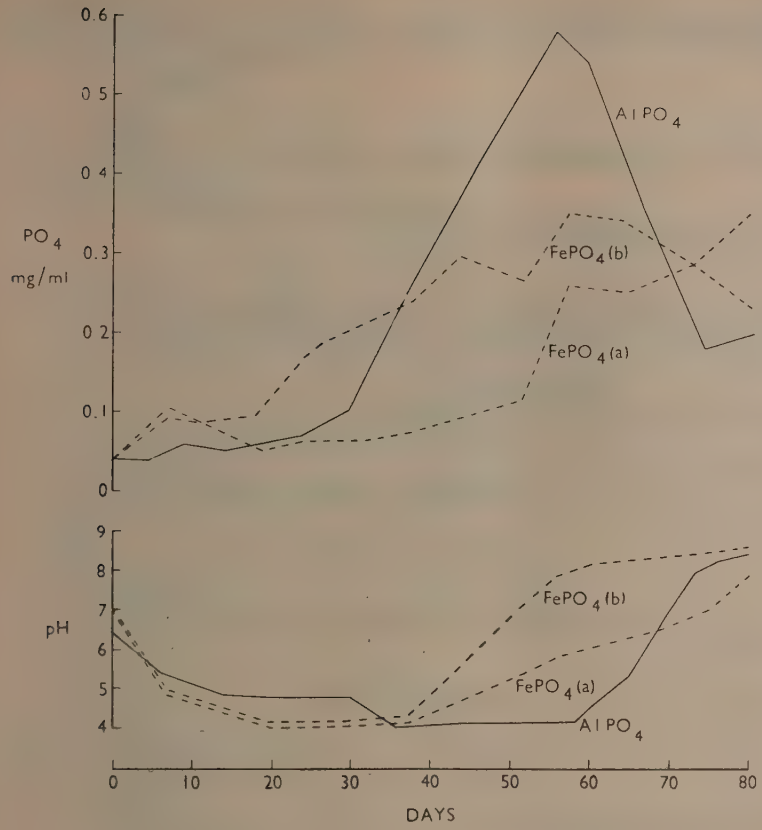

Figure 2—Trends of phosphate solubility and pH with time in cultures containing either aluminium phosphate or ferric phosphate;
———. plot for mean of duplicate cultures.
- - - - plot for individual cultures.

Acknowledgement

The author wishes to thank Mrs. M. Stiller for her technical assistance.

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Canberra.

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Thesis Summary

An Investigation of the Viruses which Cause Woodiness of Passion Fruit

A study of the host range and physical properties of the virus which causes woodiness of passion fruit in Victoria indicated that it is a strain of cucumber mosaic virus (C.M.V.). This was substantiated by cross protection tests using a known English strain of C.M.V. In these tests it was shown that the passion fruit strain protected spinach and *Nicotiana glutinosa* test plants from subsequent infection by the English strain of C.M.V. However, the English strain of C.M.V. did not protect spinach test plants from invasion by the passion fruit strain. The passion fruit strain entered spinach plants prior infected with the English strain and gradually dominated it. The resultant disease was of similar severity to that which occurred in spinach plants infected by the passion fruit strain alone. This also indicated a strain relationship, as when unrelated viruses co-exist in a plant they usually produce a more severe disease than that caused by a single infection of either strain.

Field and glasshouse symptoms of C.M.V. infection of *Passiflora edulis* and *P. caerulea* seedlings and the grafted vine which consists of a *P. edulis* scion and a *P. caerulea* stock are described. Symptoms on the *P. edulis* scion of the grafted vine were usually more severe than those shown by *P. edulis* seedlings. In some cases decline and death of the scion occurred. This severe decline may be related to concentration of virus, as the results of aphid transfers indicated that *P. caerulea* seedlings normally maintained a much higher concentration of virus than *P. edulis* seedlings, and that the concentration of virus was higher in *P. edulis* scions than seedlings. The extremely low concentration of virus in *P. edulis* seedlings and the presence of an inhibitor in the extracted sap made mechanical transmission from this plant to alternate hosts impossible.

Seed transmission of C.M.V. could not be demonstrated in passion fruit. The probable primary source of infection in nurseries was shown to be from alternate hosts of the virus.

A percentage of small seedlings of both *P. edulis* and *P. caerulea* were freed from C.M.V. by heat therapy for a period of 14 days at 37° C.

A comparison of the strain of C.M.V. isolated from Victorian passion fruit and a virus which causes woodiness of passion fruit in Queensland showed that they were distinct viruses. Under similar conditions the Queensland woodiness virus was slower to produce symptoms on *P. edulis* test plants, and the symptoms produced by the two viruses were distinct. The Queensland woodiness virus could not be aphid transmitted to three common hosts of C.M.V. although it was readily transmitted to healthy passion fruit. Cross protection did not occur between C.M.V. and the Queensland woodiness virus in *P. edulis* seedlings. When the two viruses co-existed in these seedlings a very severe disease resulted, indicating that the two viruses were distinct.

R. H. TAYLOR

Awarded the degree of M.Agr.Sc. by the University of Melbourne, 1957.

The Influence of Seed Size on the Growth of Two Strains of Subterranean Clover Under Sward Conditions

This study was carried out in 1956 at the C.S.I.R.O. Field Station, "Glen Lossie", Kojonup. It was prompted by the results of a strain trial in the previous year, when large seeded strains performed much better than small seeded strains planted in swards at the same density.

The present work was designed to provide further information on this point, and on the relative performances of the two major commercial strains of subterranean clover.

Large and small seeds of the early—Dwalganup — and midseason — Mt. Barker — strains, collected by sieving large quantities of commercial seed, were planted in swards at equal seeding rates (weight of viable seed per unit area) and equal densities (numbers of viable seed per unit area).

This design enabled the effects of strain, seed size and seeding rate to be separated. The eight treatments were arranged in an 8 x 8 latin square.

Four harvests were made during winter and early spring. Tops were sampled with hand shears from two 25 square link areas per plot, and an attempt was made to estimate root yield by washing the roots from soil cores taken with a root sampling auger from the sampling sites.

Leaf and stem separations were done on fresh material from each sample, and some leaf area estimations were made.

Seed size had no effect on yield of tops or roots so long as the seeding rate was constant.

When large and small seeds were sown at the same density the swards from large seeds gave higher yields than those from small seeds. This was shown to be due to a difference in seeding rate, and was not an effect of seed size as such.

The differences due to seeding rate were always large, and most marked in the early stages of growth. High seeding rate gave a much higher absolute growth rate than low seeding rate at first, but this difference decreased with time and had disappeared by the end of the experiment. These effects can be interpreted in terms of leaf area and light interception.

Both strains reacted in the same way to differences in seed size and seeding rate.

The strain Dwalganup gave a greater yield of tops than Mt. Barker from 21 days after emergence until the end of the experiment. Leaf production was higher in the midseason strain, and its leaf yield exceeded that of Dwalganup after 70 days from emergence.

Root yields of Mt. Barker were consistently higher than those of Dwalganup, the difference becoming more marked with time. This resulted in Mt. Barker giving a slightly higher total yield, despite Dwalganup's higher yield of tops.

E. LAWSON

Awarded the degree of M.Sc.(Agric.) by the University of Western Australia, 1957.

Letters

Mistletoe Control

Dear Sir,

Some time ago we published an account of investigations on the control of mistletoe by trunk injections of 2,4-D (Greenham and Brown 1957). We reported that on seven out of the eight species of eucalypt hosts investigated, reasonable commercial control of mistletoe was obtained.

Recently Hartigan (1958) published a note on mistletoe control by various applications of 2,4-D and gave results obtained in the New England district. His results as regards kill of mistletoe are by no means as favourable as those obtained by us. We have endeavoured to reconcile the differences between the two sets of results, and accordingly have studied his internal report and other information. We wish to acknowledge his permission to cite his report, and make the following observations.

With the possible exception of *Eucalyptus sideroxylon*, it is unlikely that Hartigan was working with any of the host species that we mentioned. Moreover, he worked mainly with *Amyema miquelii*, we with *A. pendula*. It is to be expected that mistletoe response can vary with host species, nevertheless we would think that our injection method could be used with reasonable success on more than the seven species which we listed, and on mistletoes other than *A. pendula*. In fact, so far we have noted no differences between responses of the two species of *Amyema* to the 2,4-D treatments, and moreover have killed *Phrygilanthus sp.* by such treatments (Greenham *et al.* 1951).

Although Hartigan in some of his treatments apparently followed our method in detail, he introduced some important modifications. Thus he used holes three inches deep, whereas we used holes just deep enough to take the dose (Greenham *et al.* 1951). Moreover, in half of the trees given our treatment, Hartigan used only four holes per tree, not one hole per inch of diameter at breast height. We have already shown that such alterations in the method seriously reduce the effectiveness of the treatment (Greenham and Brown 1957, pp. 310-311). For his November and June treatments Hartigan used rates A and C respectively, whereas we now would use rates B and C respectively for our local species of eucalypts. Our 1957 paper mentions that two years may elapse before mistletoe deaths cease. Hartigan assessed three out of five of his seasonal treatments at 12 months or less. Although with Hartigan's October treatments further mistletoe deaths did not occur after 12 months, we point out that mistletoe response is often more rapid with spring treatments than with others.

Hartigan's note gives no indication of the difficulties encountered. Thus his three later treatments were delayed by phenomenal rain, and for a considerable period the ground was sodden. Possibly excessive soil moisture caused a poorer response on the part of the mistletoes. Since our 1957 paper was published we have obtained observational evidence that eucalypts should not be treated during drought, as they are then more susceptible and the mistletoes less susceptible (a post-publication note to this effect has been inserted in our reprints). It is rational to accept that response to 2,4-D treatments will be abnormal during abnormal seasons.

We are continuing our investigations to obtain a better selective poison than the triethanolamine salt of 2,4-D. Nevertheless, we feel that appropriate injections with that substance, on the species we have mentioned and during normal seasons, should give better control than are indicated by the results obtained in the New England district. Although our investigations have generally been on a small scale, in the absence of drought we have obtained good agreement between repeated experiments, and moreover, have obtained progressive response with increasing dose rate.

Yours, etc.

C. G. GREENHAM.

C.S.I.R.O. Division of Plant Industry,
Canberra, A.C.T.

A. G. BROWN.

Forestry and Timber Bureau,
Canberra. A.C.T.

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Private Consultancy

Dear Sir,

For many years I have had a feeling that we of this profession have not been playing the role which we should in the agricultural economy of our country. Have we really realised that by virtue of our graduation we are rightly members of a learned profession in exactly the same way as those who graduate in medicine, architecture, engineering, commerce? I think not. The proof of this statement is clear. Nobody would be allowed to practice medicine or law or engineering if he did not hold a practising certificate of some legally recognised nature from a committee legally set up to rule the profession. In regulating the profession this body would be concerned mainly in the protection of the public against unskilful or unethical activities and in the protection of its members against competition from unqualified people.

By way of contrast what is the position of a farmer seeking the solution to a problem? First of all he will rightly see what neighbours have to say. If they do not know the answer, he may ask a Departmental Officer to call, but as such officers have such large districts, he may have to wait, and in any case he is not likely to have a very lengthy use of the officer's time. There would also be cases where an officer might not be allowed or even qualified to help—for example, in cases where it was necessary to interview a Bank with and on behalf of a client, to supervise the development or subdivision of a large area of land, to make a market survey for some farm equipment and machinery company, to select management or general personnel, to carry out a complete pastoral inspection in an individual case or, as a regular duty, to analyse budgets to see what economies could be effected or how funds could be used to more advantage—and, of course, to do all this and other work on a completely confidential basis as in other professions. Once a practice has been properly established one can visualise cases where regular advice has been given to a farmer who, when he dies leaving his property to the family, would want help to continue to be given to the family in the same way as from a family doctor, or a family lawyer. Thus a practice properly built up would continue indefinitely; juniors eventually taking over as they proved themselves. Anything resembling this is completely lacking in our field, and as a result I think that agriculture is the poorer and that we lack prestige and vitality.

What can a young graduate do at present? He can, if he is the right type, join a research organisation like C.S.I.R.O., or the research branches of the Departments of Agriculture. Otherwise he must join a Department of Agriculture or, if he has not his own farm, seek employment right outside the field in which he graduated. We do find many agriculture graduates working successfully in entirely different fields showing that as a brain training the course is excellent, but as a career it is ridiculously limited.

It is my firm view that we have done wrong to virtually socialise agricultural services. There are some who feel that it is good that people should get their advice for nothing but if you examine the facts thoroughly you will inevitably come to the conclusion that in the first place the real service that is given is very sketchy, and as a result there is a virtual army of amateurs dishing out what may be, but what often is not, helpful advice. I think that it is beyond doubt that trained agriculturists are mainly employed either in experimental work, or in putting out very general information, while the untrained ones are the ones who are making the vital contacts with the producers. There are, for example, a vast number of people called Pastoral Inspectors operating in Australia, and I would be surprised to find that one per cent. are trained in agriculture, or even keep up to date in technological knowledge. Why is this? Obviously because the trained man has been content to remain socialised and has not been confident enough to enter the really practical field, or, one could say that he has not had enough fight in him to battle for the establishment and recognition of his profession. Because he has let this happen, it is no easy matter now to reverse the trend, but I think that we owe it to ourselves and to the public to do so.

What have we to face? I have found only too clearly what the obstacles are. First of all, there is a general impression, because we have not hitherto entered the private field, that if we are asked the answer to a problem, we will either be vague, or will want to carry on an interminable experiment. Our attitude, to the public, is one of experimentation, but when a man is in trouble, the only time when he is likely to call us in, he wants an immediate answer and I think that in most cases we can give him one. We know enough to be able to say in the vast majority of cases that if a farmer does so and so, the downward curve can be levelled out and some upward trend shown. The fact that the upward curve could be accelerated if we knew more is immaterial—that is for the researcher—but

we have achieved something in starting its upward movement, and that is what counts. Again, the farmer thinks that we will only look at the highly technical problems of pasture or animal, whereas his real problem may be one of finance, of organisation, of personnel, or of the hundred and one things which enter into his whole farm problem. If we can't look at his problem as a whole, make a quick but thorough diagnosis, prescribe a workable cure, and supervise the treatment until the problem is solved, we are of very little use to him. We have not so far done this, so we are looked on with suspicion, and rightly so.

If a young man is contemplating a university career, he has a number of choices open to him. If he studies medicine, he knows in advance that he has eventually a wide field of opportunities. If he likes research, there are excellent medical research institutes open to him. If he seeks the security of a government position he can go in for public health. If he wants a salary and experience, he can join a hospital staff. If, on the other hand, he so wishes he can become a general practitioner and, in due course, he may decided to become a specialist. Thus, his individuality as well as his knowledge can find expression. In whatever avenue he works he knows that he will benefit from the prestige of a great and noble profession. In agriculture, however, his knowledge may find a field, but his individuality won't; hence, in the first place, comparatively few will choose agriculture, and those who do will not enjoy the prestige which would be accorded to those others of his school mates who graduated in other faculties.

This is not good for our country, and I venture to say that although we have done a good deal in agriculture in Australia, we would have done much more had farmers been able to ring up and receive an immediate visit from a fully qualified practitioner in the nearest country town at a fee comparable with that of the local doctor. Such practitioners would have to be good, because livelihood would depend purely on the extent which people were willing to use them. Their practices would be permanent and they would have an accumulated and immediately available source of local as well as general knowledge of a technical kind, plus a very good knowledge of the people with whom they were dealing. No such person at present exists, even though it must be obvious that once established and accepted, he would be quite irreplaceable in a farming community which sought efficiency and security, and peace of mind.

I think that the first step is for members of the A.I.A.S. to think very deeply about this from every angle and if they then accept the underlying basis, to discuss ways and means of bringing about the birth of the profession of private practitioners. It is my own opinion that we must first get the large institutions, such as banks, trustee companies, stock and station companies and pastoral companies, to support us and that prove in our relationships with them that we are practical, that we can give them immediate and concrete help, that we can give specific, sensible answers to specific questions, that we are thoroughly capable of good, sound, logical diagnosis, the appropriate prescription and the complete cure, that we are providing a vital service to the community which has not hitherto been given. When we have established this phase, we can start moving out into the country towns giving direct service to those farmers who ask for it.

No campaign, however, was ever successful without the proper training of those who are to be engaged in it, and therefore I think the start should be gradual so that those who show a flair for this kind of work can train juniors properly who, in their turn, will train more.

It may even be that something will have to be added to the university course, something which, for want of a better name, would be called Commercial Agriculture, and which would stress particularly logic in diagnosis and, by reference to cases, the need to consider all the elements in an overall farm problem. It would also have to include some consideration of those general problems which would be referred to a private practitioner—problems of finance, marketing, psychology, and so on. From my own experience to date, I think it would also have to be stressed to students that you must above all learn to be a very human being.

Yours, etc.

W. A. BEATTIE.

Pastoral Consultant,
East Melbourne.

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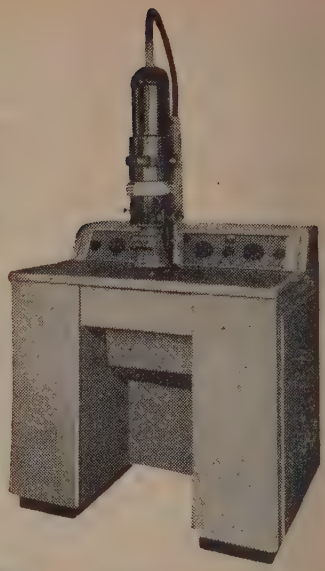

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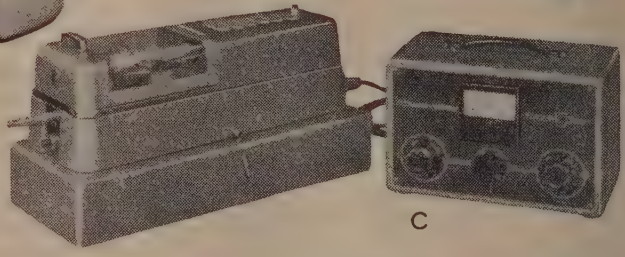

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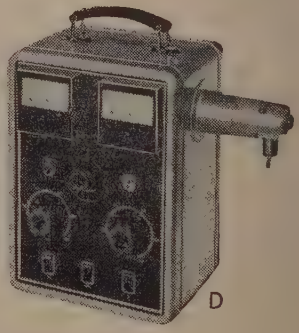

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Talks

Aspects of Agricultural Research, Extension and Farming in Russia

Dr. R. J. Swaby in an address to S.A. Branch.

Dr. Swaby first pointed out the difficulties of arranging this visit. With no diplomatic relations between Australia and U.S.S.R. it was not possible to visit as an exchange scientist, and permission was required from the Australian Department of Immigration and the U.S.S.R. Embassy in either Washington or London. Before a visa was granted, it was necessary to submit an itinerary containing names of Russian workers and their addresses. These proved very hard to get. No addresses were available from the embassies or the U.S.S.R. Academy of Science but a few were obtained from Rothamsted and the Royal Society.

A visa was eventually granted for a two weeks' visit as a tourist at £13 per day. This fee included all fares, accommodation and the services of an interpreter and chauffeur driven car.

Once in Russia it was still very difficult to persuade the guides to arrange visits to the Institutes desired. When finally achieved, the scientists were frank and friendly.

Russian research is planned by the Lenin Academy of Science. Among the sixteen institutes visited were the University of Moscow, an enormous building with 24,000 students, the Institute of Medical Microbiology, Virology and Serology which was beautifully equipped, the Dokuchaev Institute of Soil Science, the Timiryazev Academy of Agricultural teaching and research and the Research Institute for Farming in the Central District.

Research Institutes. The Dokuchaev Institute of Soil Science, where Glinka worked, was an old four storey building surrounded by slums. The present director is Tiurin and there are 150 scientists and 150 technical assistants working in twelve departments covering most phases of soil science.

The Research Institute of Farming in the Non-Chernozem Zone was 20 km. from Moscow and was a poorly equipped building with two departments, viz. Chemical Fertilizers and Bacterial Fertilizers. Different strains of rhizobia are used for different soils as well as legumes. Improved growth resulted from using Azotobacter chroococcum with non legumes as well as legumes.

Farming. There are no privately owned farms in Russia—they are either State farms (6,000) operated by civil servants or Collective farms (80,000) operated on a co-operative basis.

The October Collective Farm near Kiev occupied 15,000 acres and produced an income for 1957 of 8 m. roubles (£400,000). It contained 12,000 people of which only 1,500 were full time workers. The property was divided into 13 brigades and managed by a board of 10 made up of technicians and farmers. The farm carried 1,260 cattle, 2,000 pigs, 270 horses and 4,000 beehives. Amenities included a High School, Hospital and Store. Twelve per cent. of the homes had T.V. and 60 per cent. radio, but there were only 10 cars on the property.

The average crop yields were wheat 37½ bushels/acre, rye 32 bushels, potatoes 12 tons/acre and apples 2.6 tons/acre.

From these crops, 10 per cent. is sold to the State, 10 per cent. retained for seed, 50 per cent. goes for workers' pay, 4 per cent. to an aid fund and 20-30 per cent. is used for fodder for farm livestock.

Each farmer has ¾ acre attached to his home and this is worked independently. The surplus can be sold to the State, the Co-operative or on a street market.

Extension. The Agronomist is the key to extension services. His know-how comes from the Universities, Research Institutes and Experimental Stations.

Dr. Swaby was most impressed by the permanent agricultural exhibitions in the cities. An example of this was the Exhibition in Moscow with its 300 pavilions spread over 500 acres.

In conclusion it was felt that—

1. Farming technique has improved sufficiently to prevent famine but there is still a deficiency in some products, e.g. meat and fruit.
2. Production of fertilizers, pesticides and fungicides is inadequate.
3. There is a need for refrigerated transport and cool stores.
4. Light industry in rural areas would make use of surplus labour.
5. Luxuries (e.g. chocolate) are very costly.

The Place of Private Industry in Agriculture

Mr. F. J. D. Thomas, Director of I.C.I. Laboratories, Merrindale, Victoria, in an address to S.A. Branch, December 1, 1958.

Mr. Thomas restricted his coverage to the chemical companies which are linked with agriculture.

He stressed that the proportion of private research to official research is small in Australia compared with overseas because of the small size of the majority of the companies and the fact that research must be paid for from profits.

I.C.I.A.N.Z. is the largest company in Australia and the world expenditure by this company on research is double the C.S.I.R.O. budget.

Companies must be selective in their research objectives, and are hampered by lack of precise information on the relative importance of problems.

Mr. Thomas detailed the programme involved in the development of a new pesticide indicating the role of the chemist, biologist, statistician and toxicologist. The cost of developing a new compound was between half and one million pounds.

In the field of fertilizer research Mr. Thomas foresaw considerable expansion as land becomes more expensive and less plentiful in Australia, and the need arose for more precise fertilizer usage. He stated that in the U.K., I.C.I. runs three whole farms solely for the purpose of testing various methods of using Ammonium Sulphate and uses 100 co-operative farmers to provide cost details on the usage of this fertilizer.

Mention was made of other fields in which private companies had contributed to the "tools of trade" of farmers including agricultural machinery, concentrate spraying equipment, plastic piping and sheeting, and new packing materials.

In discussing related research organizations Mr. Thomas cited examples of—

(a) Independent Institutions which carry out research on a contract basis.

(b) Research Association, e.g. the Bread Research Institute, where several companies contribute to a common research programme.

(c) Farmer and Grower Organizations, e.g. the Bureau of Sugar Research.

The increasing tendency of the agricultural industries to appreciate and support official research as exemplified by the Wool, Wheat and Tobacco Industries was considered a very satisfactory approach for Australia to adopt.

Considering the future role and requirements for Agricultural Science graduates Mr. Thomas stressed the desirability of free interchange of trained personnel between Universities, State, Commonwealth and Industry to promote greater efficiency in the utilization of talent.

The requirement by Industry for men with the broad training of the general agriculture degree would be high in the near future. The requirement for specialists would be low and suggested that the most efficient method of training these specialists would be to establish good post-graduate schools in each field in a limited number of places rather than at each University.

Conditions of employment in Industry for graduates have improved now that it is "not necessary to sell one's soul as well as one's services". Furthermore, the suspicion between private and official research workers is breaking down, there is greater collaboration, e.g. at specialist conferences, publication is encouraged, and salaries and conditions are comparable with Government Service.

Mr. Thomas closed on the note that Industry relies on State and Federal Research to provide background information and basic knowledge and to evaluate the results of industry research in terms of the integrated whole, e.g. chemical control of disease as opposed to resistant varieties.

News Items

A.N.Z.A.A.S. Perth

The criticisms levelled at the Australian and New Zealand Association for the Advancement of Science by the President of the Adelaide Congress last year, Sir Marcus Oliphant, and by the Adelaide press will be answered in the organisation of the next Congress, to be held in Perth from Monday, August 24 to Friday, August 28, 1959, according to the honorary local secretary, Professor D. E. White of the University of Western Australia.

Traditionally A.N.Z.A.A.S. Congresses have been devoted to discussions, amongst scientists, of the most recent advances in their special fields with a few public lectures in which eminent scientists have discussed recent scientific work for the benefit of the general public. The result has been a relative neglect of the stated aim of A.N.Z.A.A.S.—to promote a spirit of co-operation between scientific workers and scholars and those in sympathy with science and scholarship generally.

This year scientific lectures and discussions of current importance will be arranged for the man in the street. Some of these will be formal public lectures at 8 p.m., but it is also proposed to hold a series of informal lectures followed by discussion at about 5.15 p.m., following the example of the Adult Education Summer School. Daytime sessions will also be held for the general public—especially for teachers who will be on vacation during the Congress.

A young people's programme is being arranged, with the co-operation of the Education Department, and all secondary school children with an interest in science will be able to attend some of the specially designed talks to be given by eminent scientists.

In addition to these programmes there will be specialist papers and discussions (sometimes in collaboration with specialist societies like the Australian Mathematical Society, etc.) and symposia in which scientists specialising in diverse fields contribute to common problems.

Membership for the Congress does not require any scientific qualifications and costs £2. Wives of Members and students at the University, Technical Colleges and secondary schools may be admitted as Associate Members for £1.

Members who wish to maintain an interest in the Association may pay an annual subscription of £2/2/-. They then receive the *Australian Journal of Science* (published monthly). A subscription dating from 1st July, 1959, is required to cover the Perth Congress.

Enrolment forms and further information may be obtained from the honorary local secretaries: Australian Capital Territory: W. Hartley, Division of Plant Industry, C.S.I.R.O., Box 109, City, Canberra; New South Wales: Professor J. R. A. McMillan, Science House, 157 Gloucester Street, Sydney; Victoria; J. F. H. Wright, Industrial Research Liaison Section, C.S.I.R.O., 314 Albert Street, East Melbourne, C.2; Queensland: Professor Mansergh Shaw, Department of Mechanical Engineering, University of Queensland, Brisbane; South Australia: R. S. Burdon, 10 Fisher Street, Tusmore; Western Australia: D. E. White, Chemistry Department, University of Westtern Australia, Nedlands; Tasmania: K. D. Nicholls, Division of Soils, C.S.I.R.O., Stowell Avenue, Hobart; Papua-New Guinea: G. A. V. Stanley, c/o Australasian Petroleum Co., Port Moresby, Papua.

Section K

For Section K (Agriculture & Forestry) the committee has invited papers on the following topics:—

Planned land use in higher rainfall areas.
Pasture establishment on light lands.
Phosphorus in soils and plants.
Conservation of soil resources.

It is also proposed that three symposia be held in conjunction with other sections (shown in brackets).

(1) The design of farm machinery (H).
(2) Toxic effects from improved pastures (L).
(3) Use and abuse of natural grazings in semi-arid regions (M).

New Status for C.S.I.R.O. Wool Research Laboratories

C.S.I.R.O.'s three Wool Textile Research Laboratories have become Divisions of the Organization.

The Melbourne laboratory becomes the Division of Protein Chemistry, the Sydney laboratory the Division of Textile Physics, and the Geelong laboratory the Division of Textile Industry.

In future this group of Divisions will be called the C.S.I.R.O. Wool Research Laboratories. These laboratories were established by C.S.I.R.O. in 1949 in the three main centres of the wool textile industry in Australia—Melbourne, Sydney and Geelong.

The Officer-in-Charge of the Melbourne laboratory, *Dr. F. G. Lennox*, becomes the Chief of the Division of Protein Chemistry, the Officer-in-Charge of the Sydney laboratory, *Mr. V. D. Burgmann*, becomes Chief of the Division of Textile Physics, and the Officer-in-Charge of the Geelong laboratory, *Dr. M. Lipson*, becomes Chief of the Division of Textile Industry.

The three new Divisions will continue to work together as a close-knit group. The three Chiefs will function as a committee to co-ordinate their activities.

The Division in Melbourne will be concerned mainly with research on the structure and chemistry of wool but will also continue investigations on some industrial textile processes.

In Sydney emphasis will be placed on physical studies of the wool fibre such as its capacity to absorb moisture and its crimp, strength and elasticity, and the development of new textile processes as additional information becomes available from the more basic studies.

The Geelong Division will give major consideration to the immediate needs of the wool textile industry.

The research work in all three Divisions will be directed to improvements in existing wool textile processes and the development of new processes. The research will allow new properties to be conferred on wool to meet particular needs of the consumer.

Pastoral Research Station for Western District

The Victorian Government has purchased a property of 837 acres near Hamilton for use as a pastoral research station to serve the important Western District of Victoria. The property is situated on the Mount Napier Road five miles south of the City of Hamilton. The research work to be conducted on the new station will be a co-operative effort between the Commonwealth Scientific and Industrial Research Organization and the Victorian Department of Agriculture, and will deal with both pasture and live stock problems. Particular investigations will centre around the decline in quality of older sown pastures while, on the live stock side special attention will be given to the heavy losses of new born lambs occurring throughout the Western District and the difficulty in maintaining growth of lambs from the weaner to the hogget stage.

These and associated problems will be investigated by carefully planned field experiments and it is hoped that after a period of years the work will lead to a marked improvement in standards of pasture and live stock management.

Economics Society

The Australian Agricultural Economics Society, which was formed in February, 1957, held its third conference in Melbourne in February last. This society has now a widely representative membership of agricultural economists in Australia and overseas.

To further its objectives the society has undertaken the publication of a Journal entitled "The Australian Journal of Agricultural Economics."

Three issues have been produced. The first two comprised the proceedings of the 1957 and 1958 conference respectively (Vol. I and Vol. II, No. 1). The third, published in December, included contributed articles (Vol. II, No. 2).

The contents of the first two issues are shown hereunder—

Contents Vol. I

Agriculture in the Balance of Payments—J. G. Crawford.

Symposium—Contemporary Agricultural Economics in Australia—Keith O. Campbell and D. B. Williams.

Uses and Limitations of Farm Surveys—Henry P. Schapper.

Resource Productivities and Production Functions—F. G. Jarrett.

Quality in Relation to the Marketing of Primary Products at Home and Abroad—T. H. Strong.

Capital Formation in Australian Agriculture—F. H. Gruen.

Contents Vol. II, No. 1

The Challenge of Production Instability in Australian Agriculture—Keith O. Campbell.

Symposium—Agricultural Experiments and their Economic Significance—P. J. Skerman and A. G. Lloyd.

Some Observations on Agricultural Marketing Research and the Need for its Development in Australia—T. H. Strong.

Trends in Agriculture's Terms of Exchange—J. N. Lewis.

Australian Agricultural Statistics: Some Aspects of the Classification of Farms by Size—R. G. Walker.

The Challenge of the Dairy Industry—Hedley C. Clark.

All communications concerning the Society should be made to the Hon. Secretary, Mr. C. P. Dowsett, c/o Rural Bank of N.S.W., Martin Place, Sydney.

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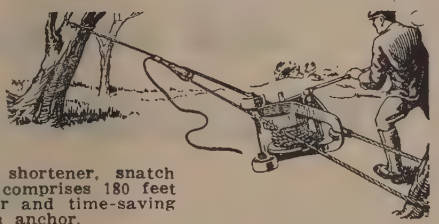

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Gerald de Vahl Davis

Gerald de Vahl Davis, the founder of the Australian Institute of Agricultural Science and the first signatory in its register of Foundation Members, died suddenly while playing bowls privately with his wife and a few close friends at Bellevue Hill, Sydney, on Saturday afternoon, November 22, 1958.

Born on April 8, 1897 in Melbourne, Gerald Davis was educated at Sydney Grammar School and the University of Sydney where he obtained his B.Sc.Agr. degree with 2nd class honours in 1921. Davis commenced his University course in 1915, but enlisted the following year and served as a Sergeant in the 6th Australian Light Horse in Egypt and Palestine. He was wounded in 1918 and actually commenced his University work again in April 1919 whilst still in military hospital. In World War II he served in the Mobile Signals with the rank of Captain.

After graduating he spent a short time as a Field Officer with the N.S.W. Department of Agriculture in the South West of the State where he later purchased a property at Junee Reefs. He farmed there until 1925 when he returned to Sydney as Chief Chemist for the Davis Gelatine Co. Ltd., and although not related to the proprietor of this firm, the latter quickly recognised his business acumen and soon appointed him Sales Manager.

In 1929, whilst overseas, Gerald Davis was appointed Australian representative for both the French and German potash interests and subsequently when the Australian company, Pacific Potash Pty. Ltd. was established he was appointed Managing Director. Later, after World War II when the French and German potash interests again amalgamated and the new company, Potash (Australasia) Pty. Ltd., was formed, Davis was the logical choice for the Managing Directorship. Thus from 1929 until his death he virtually had complete control of the potash industry in Australia. During the whole of this period he only had two Secretaries —a magnificent tribute to his qualities as an employer.

In the course of his business career Davis made many overseas trips and he attended a considerable number of international soil, fertilizer and grasslands conferences. He also travelled frequently between the capital cities of Australia, and this mobility was one of the reasons he was able to play such a vital role in the foundation of this Institute in the early thirties.

Who first conceived the idea of forming an Australia wide Association of Agricultural Graduates I do not know, but I think it was probably J. L. Gillespie of Victoria. Certainly it was Leith Gillespie who, on May 20, 1932 first discussed this proposal at an informal meeting of graduates held in the Biological Branch of the Department of Agriculture in Sydney, and reference to this meeting was made by H. J. Hynes in an editorial in the December 1932 issue of *Suaga*. When Gillespie and Davis first got together on this subject I don't know but by early 1933 there had already been a number of informal discussions, jointly or severally, between these two, Harold Hynes and myself.

However on Friday June 23, 1933, Gerald Davis certainly took the first positive step in the long chain of events which eventually led to the formation of the Institute, when he phoned me, as Secretary of the Sydney University Agricultural Graduates Association, and asked me to come over to his office to discuss ways and means of getting things started. As a result of this discussion Gerald agreed to prepare a case and a draft constitution for submission to the next meeting of S.U.A.G.A. This meeting was held in the rooms of the Chelsea Book Club in the State Theatre Building, Market Street, Sydney on Monday evening, August 21, 1933, and as H. J. Hynes said in his editorial in the September 1933 issue of *Suaga* . . . . . ". . . Mr. G. de V. Davis spoke on the desirability of forming an Australian body and by reason of his intimate acquaintance with graduates' views on this matter in other States and his knowledge of the workings of similar institutions in other countries, he was able to present before members some very concrete proposals for the establishment of a Federal body in Australia."

As a result of the thorough and able way in which Davis had prepared his case and the lucid and forceful way in which he presented it, the meeting agreed unanimously "that a federation of men and women interested in the profession of Agricultural Science in Australia should be formed and that the Agricultural Graduate Society in each State should be invited to consider the proposal".

The meeting also approved in general principle the aims and objects of the Association as set out

in Davis' original draft constitution which had been circulated to members prior to the meeting.

Gerald Davis did a tremendous amount of work in preparing this original draft constitution and spent many hours consulting the constitutions of various other professional organisations. Subsequently as the Chairman and Convenor of the Constitution Committee set up by the Sydney Agricultural Graduates Association, he was largely instrumental in co-ordinating the views of agriculturists in all States and drafting the final constitution basically acceptable to all concerned.

My close association with Davis during this period engendered a very high regard for his mental agility and the clear cut incisive qualities of his mind. In later years it was my privilege to serve on many other Committees with Gerald Davis, particularly during the four years the Institute Office of Management was located in Sydney, and it was always a revelation and an inspiration to see him at work. He was easily the best committee man I have known. His knowledge of procedure was flawless. His thinking was direct and clear and I have never known anyone who could frame a resolution with such clarity and speed or who could simplify a mass of confused ideas with such unerring skill and dexterity.

From the time Gerald Davis turned the first Institute sod in August 1933 up till he piloted the proposal through the eventful meeting which terminated in the Melbourne School of Agriculture at 1.40 a.m. on the morning of January 18, 1935, it would be impossible to estimate the enormous amount of time and energy he had devoted to Institute affairs.

Throughout his life he continued to serve the Institute which he had created. He was President of the N.S.W. Branch in 1937 and was the Federal President in 1947. The previous six presidents had either been Professors of Agriculture or Divisional Heads of C.S.I.R.O. and each had held office for a period of two years. Davis however held office for one year only and refused to accept a second term as he believed the office of President was an honour which should be liberally bestowed, a principle which the Institute adopted forthwith.

Gerald Davis' interest in the welfare of Australian agriculture and his magnificent work for the Institute were only one facet of a full and versatile life. He was eminently successful as a business man and yet found time for a wide range of activities in public and Church life.

He was an alderman of the Woollahra Council continuously from 1949 until his death. He was Deputy Mayor in both 1951 and 1955 and was Vice-Chairman of the Finance Committee in 1954. He was particularly interested in the park development and street beautification activities of the Council. On two occasions he unsuccessfully contested Parliament as the endorsed Liberal Party candidate in extremely strong Labour electorates and in one of them he was the first Liberal candidate not to lose his deposit.

After World War II he became very interested in the work of the United Nations Association of Australia and was a member of its Executive of the N.S.W. Division and Chairman of its Standing Committee on F.A.O.

He was a very prominent member of the Sydney Jewish community and took an active part in Church and Welfare organisations. He was a Foundation member and a Life Vice-President of Temple Emanuel at Woollahra and was a former President of the Jewish Board of Deputies and of the N.S.W. Jewish War Memorial. He was Chairman of Mutual Farms Pty. Ltd., an organisation for settling Jewish migrants on the land in N.S.W. and he was a former Acting President of the Jewish Welfare Society. He also served on the Council of the N.S.W. Association of Jewish Ex-Servicemen and Women and helped to establish the Rehabilitation Trust Fund of which he was a member of the Board of Governors up to the time of his death. He was also a member of the Executive Council of Australian Jewry.

Gerald Davis will be missed by all who knew him. He led a full and satisfying life and he died as he would have wished—enjoying himself in the company of his wife and a few close friends. He leaves a widow and one son, Dr. Graham Davis, who is a research engineer with the Australian Atomic Energy Commission at Lucas Heights, Sydney.

E. T. EDWARDS.

J. A. Aird

It is with great regret that we record the recent death of Mr. J. A. Aird.

Mr. Aird was a well known Institute Member who held many important posts during his distinguished agricultural career. Perhaps his best known appointments were as Member of the Victorian Closer Settlement Commission from 1933 to 1939; as Chief Irrigation Officer with the Victorian State Rivers and Water Supply Commission from 1939 to 1949; and then as State Rivers and Water Supply Commissioner from 1949 until his retirement in 1958.

In addition to these official duties, Mr. Aird was also active as a Member of the Faculty of Agriculture at the Melbourne University, since 1928, and as a Member of the Board of Studies in Public Administration since 1935. During 1938, he was President of the Melbourne University Agricultural Society and in 1943 he served the Institute of Agricultural Science in the capacity of President of the Victorian Branch.

After his retirement, Mr. Aird travelled to England and America, lecturing and renewing his old friendships in these countries. His death occurred shortly after returning to Melbourne.

Personal Notes

Australian Capital Territory

The following Canberra members attended the Agrostology Conference at Armidale, *Dr. O. H. Frankel, Mr. R. M. Moore, Mr. J. H. E. Mackay, Dr. F. H. W. Morley, Mr. W. M. Willoughby, Dr. J. R. McWilliam, Mr. R. N. Oram, Mr. J. Arnold, Mr. C. A. Neal Smith, Mr. H. Lloyd Davies, Mr. E. Biddiscombe, Mr. Hely, Dr. J. Lonergan, Dr. A. J. Anderson.*

Dr. D. M. Moore and *Mr. A. Costin* visited Macquarie Island during the change-over period in December. They were concerned with the ecology of the flora and the relationships between similar and identical species on Macquarie Island and in Australia and New Zealand.

Mr. Hadyn Lloyd Davies will be leaving Canberra in February and going to the W.A. Regional Laboratory of the C.S.I.R.O. where he will continue his work on pasture utilization. Mr. Lloyd Davies has been an active and enthusiastic member of the A.C.T. Branch and served as Sub-Editor for three years.

Recent appointments of interest in the Division of Plant Industry are *Dr. B. Latter,* a mathematical geneticist; *Dr. J. R. Simpson,* a soil chemist with the ecology and agronomy group, and *Mr. N. E. Rider,* a Research Fellow from the U.K. Air Ministry, who will be concerned with microclimatology.

Dr. Guy Smith of the U.S.D.A. Soil Survey Investigations will be visiting the C.S.I.R.O. Soils Unit at Canberra on the 24th and 25th of February.

Dr. M. J. T. Norman of the C.S.I.R.O. Division of L.R.R.S. stationed at Katherine, N.T., has returned from a tour of research centres in S. Eastern and S. Western U.S.A.

Mr. F. O. Grogan recently returned from Geneva and London where he took part, as Australian representative, in conferences relating to the Inter-

national Sugar and Wheat Agreements and also in the 13th Session of G.A.T.T.

Mr. Dick White is relinquishing the Utopian life at the Bureau of Primary Industry to go back to forecasting at the Sydney Weather Bureau.

New South Wales

Mr. John P. Kennedy has been selected Rhodes Scholar for 1959. John, following a distinguished undergraduate career, graduated with honours from the School of Wool Technology, University of New South Wales, 1957. Since graduation, as a General Motors-Holden Research Fellow, he has continued studies in that School in the field of animal genetics, having as his main interest an investigation of the inheritance and inter-relationship of wool and lamb production in merino sheep.

John will leave in August for Oxford University where he expects to enter Balliol College.

The Institute congratulates John on selection for the Scholarship and wishes him a pleasant and successful period of study abroad.

Mr. J. W. McGarity returned from the United States in December after spending two years at the University of Oregon in the Department of Soil Science. He has accepted a Lectureship in Soil Science at the Waite Institute.

Dr. C. J. Magee, Chief Biologist with the N.S.W. Department of Agriculture, has been appointed Chief of the Division of Science Services within the Department.

Mr. Brian Fox, Technical Sales Officer with I.C.I.A.N.Z., is leaving shortly on an overseas visit on behalf of the company.

Mr. E. J. Driscoll will be taking up a Research Assistantship at Cornell University later this year. He will be studying the genetics of the small grains under the direction of Professor W. F. Jensen.

Mr. W. F. Musgrove has recently completed a period of post-graduate study in Economics at Sydney University and has accepted a position with the Rural Liaison Service of the Commonwealth Bank in Sydney.

Associate Professor J. M. Vincent has gone on Sabbatical leave from Sydney University. While overseas he plans to spend some time at Rothamsted Experimental Station and the University of Wisconsin as well as visiting research centres throughout the United Kingdom, Europe and the United States.

Professor K. O. Campbell, Research Professor in Agriculture, University of Sydney, has left on Sabbatical leave. He will spend some months with F.A.O. in Rome and afterwards will visit the United Kingdom before going on to the United States where he will visit various Universities on a Carnegie Fellowship.

Mr. F. C. Crofts has recently been appointed Senior Lecturer in Agronomy in the University of Sydney.

Mr. R. T. Shand has been awarded the degree M.Sc.Agr. for a thesis entitled "A Study of the Economics of Pasture Improvement on Selected Farms in N.S.W." He is now doing post-graduate research at Iowa State College, U.S.A.

Mr. J. A. Beattie, Division of Soils, C.S.I.R.O., stationed at Griffith, recently left for the United States where he will be engaged in post-graduate research on soils at the University of Oregon.

Dr. R. R. Storrier has recently been appointed Senior Research Officer at the Agricultural Research Institute, Wagga Wagga. He will be working on soil nitrogen problems. Dr. Storrier has been employed in the Chemist's Branch, N.S.W. Department of Agriculture, since his return from Rothamsted.

Mr. David Goodchild recently returned from the University of California, Los Angeles, where he worked with Dr. Sam Wildman.

Dr. B. G. Davey recently resigned from the Chemist's Branch, N.S.W. Department of Agriculture, to accept a Lectureship in Soil Science within the University of Sydney.

Mr. J. A. Seberry and *Mr. C. R. Turkington* have been appointed Fruit Officers in the Division of Horticulture, N.S.W. Department of Agriculture. Mr. Seberry will be stationed at the Gosford Citrus Wastage Research Laboratory, and Mr. Turkington at the Griffith Viticulture Nursery, where he will be carry out research in grape and wine production.

Mr R. A. Date will leave later this year for the University of Maryland, where he will study for his Ph.D. degree under Professor Wagner, on agronomic applications of Rhizobium. He will be accompanied by his wife, formerly Janice Quigan.

Dr. E. T. Edwards, who has been Director of Public Relations and Publicity at the University of New England since July, 1955, has resigned to accept the position of Director of Sales for the Geo. Fielder group of companies. He will take up his new position in Sydney early next year.

Northern New South Wales Sub-branch

Conferment of Honory Degree on Dr. J. G. Davies by the University of New England

On the 11th December *Dr. P. A. Wright,* Deputy Chancellor of the University of New England, at a ceremony held during the Australian Agrostology Conference at Armidale, conferred the degree of Doctor of Science, *honoris causa,* on *Dr. J. G. Davies,* Associate Chief of the Division of Plant Industry of C.S.I.R.O., and Officer in Charge of the Plant and Soils Laboratory at Brisbane.

The eulogy delivered by *Professor G. L. McClymont,* Dean of the Faculty of Rural Science, before the conferment of the degree commenced—

"It is given to few men, in their lifetime, to develop a new philosophy of approach to a major scientific and economic problem, put that philosophy into practice, see it so widely accepted that it becomes difficult for later workers to conceive that it was not always so accepted, and see the practical application of that philosophy result in immeasurable benefits to mankind. John Griffiths Davies has been one of such few."

After outlining Dr Davies' career, Professor McClymont continued—

"Dr. Davies' contributions to Australian agricultural science have thus been many; as a pioneer of what is now regarded as a basic tenet in pasture research, that the animal is a dominating biotic factor in the pasture ecosystem; as a member of the team that developed a system of pasture improvement that has transformed the southern half of the continent and contributed untold wealth to Australia; as the instigator of a chain of research stations now contributing so much to pastoral knowledge; as a teacher, guide, stimulator, critic and valued friend of the now senior generation of agrostologists, including many in this audience, and my colleague Professor Roe.

"Thus, if any man deserves the title of Father of Agrostology in Australia it is Dr. J. G. Davies."

Victoria

Mr I. D. Wardrop attended the Australian Agrostology Conference at Armidale during December.

Queensland

Members of the Queensland Branch were pleased to learn during October that *Mr. R. E. White,* a student member, had been awarded the Queensland Rhodes Scholarship for 1959.

R. E. (Bob) White entered the Faculty of Agriculture in 1955 with a University Open Scholarship after taking the Senior Examination from Maryborough High School. At the University he had a brilliant academic record, winning a half share in the Slade Scholarship in 1957 (with D. E. Blyth, also an outstanding scholar) and taking his finals in November, 1958. Bob White also took an active part in student activities, being President of the Agriculture Students' Society in 1958, and represented Emmanuel College at rowing and rifle shooting. He will leave Brisbane during August to take up residence in Oxford where he intends to do post-graduate research in soil fertility under the direction of Dr. R. K. Schofield, Reader in Soil Science.

Mr. Colin Andrew has just returned to Brisbane, travelling via England and Holland, from Cornell where he spent eleven months on a Rockefeller Scholarship. His work there was concerned particularly with the phosphorus nutrition of plants and in these studies he was able to gain considerable experience in the use of radioactive tracer techniques.

Ted Coaldrake has also returned to the Plant and Soils Laboratory after a period of twelve months at Duke University in North Carolina, where he studied the effects of fire upon ecological succession.

Mr. W. G. Wells, formerly Director of the Division of Plant Industry in the Queensland Department of Agriculture and Stock, retired at the end of 1958. For many years Mr. Wells was associated with investigations into cotton growing at Biloela.

Mr. W. J. S. Sloan becomes Director of the Division of Plant Industry and *Dr. Gordon Miles* has been promoted to be Director of Agriculture.

A number of interstate members visited Queensland after the Australian Agrostology Conference at Armidale, including the much-travelled trio from West Australia, Dr. *Reg Rossiter, Peter Ozanne* and *Alf Humphries.*

Mr. L. t'Mannetje arrived from Holland in December to take up his appointment with C.S.I.R.O., working as an ecologist on cattle pastures. Mr. t'Mannetje is a graduate of the Agricultural University at Wageningen and was married shortly before he and his wife left for Australia.

South Australia

Prof. C. M. Donald of the Waite Institute has been awarded grants to study techniques in agronomic research and student training in Ceylon, United Kingdom and U.S.A.

Dr. A. R. Callaghan has recommenced duties after three months' sick leave.

Dr. R. J. Best is abroad on study leave and will visit research institutes in U.K., Europe and the U.S.A.

P. F. Brownell has been awarded a Ph.D. by Adelaide University for a thesis on the effect of sodium as a plant nutrient.

Dr. Mayo, Messrs. K. Shepherd and *O. Byrne* attended the Genetics Conference in Melbourne in December, 1958.

Mr. M. V. Burton has been appointed Officer in Charge at the Department of Agriculture Research Centre at Minnipa.

Mr. J. R. Goode, formerly with F.A.O. in British Guiana is now Research Officer, Animal Husbandry, at the Kybybolite Research Centre.

Tasmania

Mr. P. J. Fountain has been appointed Senior Agronomist in charge of potato research in the Tasmanian Department of Agriculture, Launceston. Mr. Fountain has succeeded to the position formerly held by Dr. J. H. Wilson, who is now a senior lecturer in the School of Agriculture, Melbourne.

John Loveday of the C.S.I.R.O. soils division has returned to Hobart after a period at Rothamsted where he obtained his Ph.D. from the London University.

Among recent graduates, *Mr. B. Thistlethwaite,* Assistant Horticultural Research Officer, and *Mr. I. M. Wood,* Assistant District Agricultural Officer, have been appointed to the staff of the Tasmanian Department of Agriculture.

Mr. D. Berry, Fertilizer Sales Officer for the Electrolytic Zinc Company recently toured New Zealand to study bulk distribution methods and procedure.

Mr. E. J. Martyn has been promoted to the position of Senior Entomologist in the Department of Agriculture.

Branch Notes

Australian Capital Territory

The Final Meeting on the Theme "Australian Agriculture in the Future" was held in November and the speaker was *Sir John Crawford,* who has been knighted in the last New Year's Honours List. Sir John addressed a large audience of members and distinguished visitors on the general topic "Is an efficient Agriculture all that we need for a successful Trade Policy".

A general meeting was held to discuss the financial status of the Institute with which members were concerned; and the decisions to restrict the publication of technical articles in the journal. Discussion was brisk and two motions were presented from the meeting to the Proxy Council Meeting in November.

A successful buffet dinner was held at University House for members and their wives and it has been suggested that this become an annual function.

New South Wales

Four speakers addressed the last meeting of the N.S.W. Branch. They were:

Mr. S. Preston, "The Role of Formulation in Herbicides".

Mr. A. Nelson Johnston, "New Developments in Chemical Weed Control".

Mr. K. R. Green, "Some Weed Problems in N.S.W."

Dr. P. G. Valder, "Frost Susceptibilty in Wheat".

The addresses merited a much larger audience than was present.

Four sub-committees are at present in operation, and it is hoped that they will continue as a permanent feature of Branch organization; they are the Undergraduate Affairs Sub-Committee, the Programme Sub-Committee, the Membership Sub-Committee and the Newsletter Sub-Committee.

Northern New South Wales Sub-branch

The Northern Sub-Branch held a meeting at Armidale during the Australian Agrostology Conference, when some 75 members of the Institute were present. The meeting was preceded by a discussion chaired by Mr. Milton Moore, on the possibility of forming a Grasslands Society within the Institute.

Victoria

The annual garden party to welcome new graduates was held during December. Following a buffet meal, the President, Mr. Mackie, presented the Branch prize to the outstanding student of the fourth year.

A sherry party to welcome Sir Samuel and Lady Wadham home from their trip abroad was held on 1 January.

Queensland

The Branch's annual public meeting was held in the Shell Theatrette, Brisbane, on Wednesday the 22nd of October, 1958, the speaker for this year being *Dr. M. C. Franklin* of the McMaster Laboratory, and William McIlwraith Fellow in Animal Husbandry at the University of Sydney. The large audience of visitors and members first viewed a Shell film entitled "The Forerunner" which described the control of flood and drought which will result from the completion of the Snowy Mountains Scheme. This was followed by Dr. Franklin's address on the theme of drought control in Queensland. Dr. Franklin's estimates of the economic importance of recent droughts in this State served to emphasize the importance of the subject to everyone in the audience.

The speakers at the November meeting were the finalists for the student prize, awarded annually by the Branch for the best research project carried out by an agriculture student in the third or fourth year of the course at Queensland University. The projects are written up in the form of a short paper and the finalists each year are invited to present their papers at the November meeting. The finalists for 1958 and their subjects were:—

D. E. Blyth: The breeding system of the legume *Lotononis bainesii*.

R. E. White: The study of hydrometer methods for the mechanical analysis of soil.

Dr. E. F. Henzell, on behalf of the selection committee, announced the award of the prize to Mr. Don Blyth and congratulated both speakers for the excellent presentation of their papers.

Discussion of general business at recent meetings has dealt chiefly with the proposal for specialist sections within the Institute. Although most Queensland members apparently do not feel strongly on this subject, the general opinion so far has been against the formation of a grasslands section within the organization.

South Australia

Mr. F. J. D. Thomas, Director of I.C.I. Merrindale Research Station, Victoria, addressed the branch on December 1st, 1958, on "The Place of Private Industry in Agriculture."

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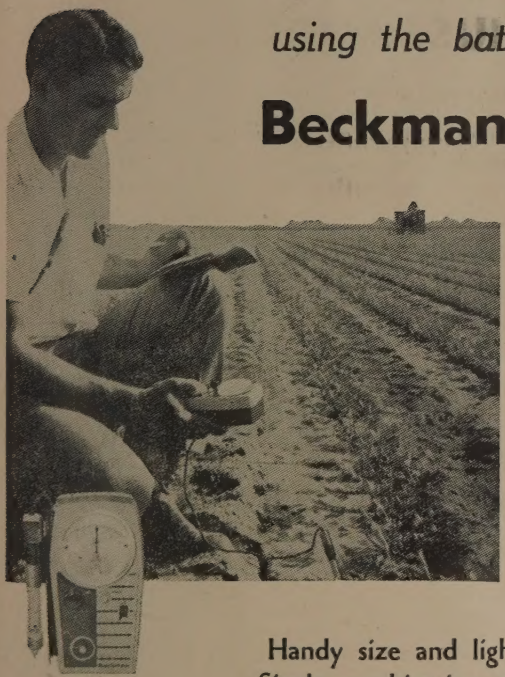

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